Light and Lighting

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Daylighting of Schools

THE current trend in the design of school buildings is the use of large areas of glass so as to admit a larger fraction of the available daylight than was formerly considered suitable. There is everything to be said in favour of good daylighting of schools, but, since good lighting is not only a matter of ample illumination but also of the avoidance of glare and dazzle, the amount of window-space must not be carried to excess. Teachers are often much impressed at first by some of the lavishly fenestrated post-war classrooms, but view them with less enthusiasm after some experience of teaching in them. Some teachers have complained that " the extreme brightness causes visual discomfort " and consider that venetian blinds, or some other protection against glare, are essential, although such means of protection are not always provided. The greatest value of a generous supply of window space is, of course, during the winter months though, even then, the low elevation of the sun may give rise to difficulties. There are also other drawbacks to very extensive windows, such as heat loss, loss of wall space for display boards and loss of room brightness when artificial lighting is in use. On this matter of classroom window size, teachers have recently made the point that " moderation in all things " is, after all, a very sound principle.

Notes and News

Electrical Engineers Exhibition

All who visited the fourth Electrical Engineers Exhibition held at Earls Court, London, from March 15-19 were agreed that it was the best such exhibition yet held; the number and variety of exhibits was not only greater than in the past, but the standard of presentation was extremely high. During the five days over 50,000 people visited the exhibition, nearly double the number of the previous year. In addition to electrical engineers, manufacturers, technicians and students from all parts of this country there were also visitors from over 30 overseas countries. A note on the lighting exhibits appears on p. 177.

There is no doubt that from its modest beginning a few years ago this exhibition has become the most important show-place of the electrical industry and the organisers, the Association of Supervising Electrical Engineers, must be very satisfied with the success of their efforts on which they deserve the congratulations of both exhibitors and visitors.

I.E.S. Summer Meeting, 1956

It is announced that the 1956 Summer Meeting of the I.E.S. will take place at Harrogate from May 8-11. Harrogate is without doubt one of the most popular conference venues in this country. It has all the facilities and knows how to use them to the advantage and pleasure of visitors so that it is always a pleasure to return there. In the past many overseas visitors have attended these I.E.S. meetings and it is hoped that they and their friends will be present at Harrogate. Even though the meeting is not for another 12 months those overseas may well wish to begin making their plans at this early stage; we understand that if they care to notify the I.E.S. secretary of their intention or hope to be present he will make a provisional booking of hotel accommodation to ensure that they are well looked after.

The type of programme at these meetings has become well established over the years and it is therefore likely that the programme at Harrogate will follow the usual pattern of good papers, visits and social events—with, of course, the display of new lighting equipment which was such a successful feature of the 1954 meeting.

The C.I.E. "Standard Observer"

The eighteenth Thomas Young Oration of the Physical Society was delivered on Friday, February 25, by Dr. W. S. Stiles, who took as his subject "The Basic Data of Colour-Matching and some Related Aspects of Visual Theory." This was a particularly appropriate choice, in consideration of the fact that Thomas Young was the founder of the trichromatic theory of colour vision on which all modern colorimetric science and practice is based.

It will be remembered that at the last session of the C.I.E. it was arranged that a fresh determination of the properties of the "average eye" should be carried out in Great Britain, in readiness for a revision of the standard observer data which had been adopted by the Commission in 1924 and 1931. This work is being done at the National Physical Laboratory under Dr. Stiles's direction and he described the very elaborate apparatus used and some of the preliminary results that had been obtained. The programme is a very extensive one. Not only are measurements to be made by a large number of observers, but the conditions of observation are to include more than one field size, because this has an important effect on the results obtained. Dr. Stiles showed some coloured discs which gave the audience an idea of what was seen by an observer and the difficulty of making matches, especially in the case of a large field.

Passing from the work of re-determining the relative luminous efficiency curve (formerly called the "visibility" curve) and the data basic to the C.I.E. system of colorimetry, Dr. Stiles described the way in which the results could be used to throw light on the properties of the three "mechanisms" which, on Young's theory, are supposed to be responsible for all colour sensation.

I.E.S. Visits

Visits to the Central Electricity Authority Research Laboratories and the Electrical Development Association Testing House, both at Leatherhead, have been arranged by the I.E.S. to take place on Friday, July 8. Coaches will leave the Victoria Embankment by the I.E.E. building at 1.30 p.m., arriving at Leatherhead at 2.30, where one party will go first to the C.E.A. Laboratories and the other to the E.D.A. Testing House. After tea the parties will change over, both visits being concluded by 5.30 p.m. After a short tour of the surrounding countryside, including Box Hill, the complete party will have dinner at the Burford Bridge Hotel. The cost of the visit, including dinner and gratuities, will be 22s. 6d. per head. Those wishing to take part should notify the I.E.S. secretary as soon as possible; ladies are welcome to take part.

The smoke-room of the new liner, the " Southern Cross."

Xenon Arc Discharge Lamps and Cinematograph Projection

A brief general account is given of the optical and electrical characteristics of carbon arcs for 35 mm. cinematograph projection. The possibilities of replacing carbon arcs in this application by other light sources are reviewed, when it is shown that high brightness xenon arc discharge lamps are suitable. Reference is made to the use of stroboscopic xenon flash discharge tubes. A short description of a recently announced system employing a 1 kw. xenon lamp for 16 mm. film projection is given.

By H. W. CUMMING, B.Sc., A.R.C.I.*

(1) Introduction

Modern cinema projection equipment handles 35 mm. film and uses as the light source a high-intensity carbon arc. With the advent of larger screens and the introduction in small numbers of three-dimensional films, necessitating the simultaneous use of two normal projectors, there has been an overall demand for more light. The carbon arc has been able to meet this requirement([1]), although certain inherent disadvantages have been further emphasised in doing so.

On a smaller scale, 16 mm. film projection is widely used on the one hand for teaching, training and instruction and on the other hand for purely amateur or hobby purposes. Equipment of this nature generally uses tungsten filament lamps. A comparable need for an increased light output has not yet arisen with this class of equipment except in somewhat specialised applications([2]).

With the introduction in 1947 of powerful new light sources making use of a xenon arc discharge([3]), where light of a sunlight quality could be produced instantaneously and efficiently, it was to be expected that these light sources and more particularly those developed subsequently([4]) would be considered as possible alternatives to carbon arcs and tungsten filament projector lamps for 35 and 16 mm. cinematography respectively.

In the sections which follow principal characteristics of carbon arcs are given after a description of the optics of a typical modern carbon arc projector. The properties of short arc length xenon lamps are reviewed and the possibilities are considered of the use of such lamps as alternatives to carbon arcs. In a final section mention is made of the particular suitability of the present day xenon lamp for 16 mm. film projection.

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(2) Typical Modern Carbon Arc Film Projection

(2.1) *General*

The essential details of the optics* of a modern carbon arc projection system are shown in Fig. 1([5]). Light from the arc proper (consisting of ionised and energised carbon vapour, metals, metallic salts, etc.) and the crater in the extremity of the positive carbon electrode, E_p, is collected by the mirror, M, and concentrated by the condenser lens, C, on to a frame of the film, lying between the guides G_1 G_2. An image of this frame is then produced on the screen by the projection lens, P. The negative carbon electrode, E_n, lies below the axis of the system and is inclined at about 80 deg. to it. As a rough indication of dimensions, the mirror, M, may be 12 or 14 in. in diameter and the arc gap about $\frac{1}{3}$ in.

The film moves down between the guides at an average speed of 24 frames per second, the actual "pull-down" taking some 0.01 second only. A shutter, S, blocks the light path over the period of movement of the film to prevent movement or "blur" of the image on the screen. This shutter also fulfils an additional important function: the human eye can detect as noticeable "flicker" a frequency below about 40 cycles per second, under the conditions of cinema screen illumination and where the light and dark are roughly of equal duration; thus a film movement of 24 frames per second would be objectionable but for an effect contributed by the shutter. The shutter is designed to interrupt the light beam twice per frame, giving an apparent frequency of 48 per second and removing "flicker." Fig. 2 gives a typical exposure cycle.

The light emission from the carbon arc does not change abruptly with time due to the thermal inertia of the positive carbon and consequently an alternating current arc, even if a power supply of frequency 24 or 48 cycles were available, would not allow dispensation of the shutter. For other reasons also D.C. arcs are employed powered

* The arrowed lines are merely intended to define roughly the limits of the light beam.

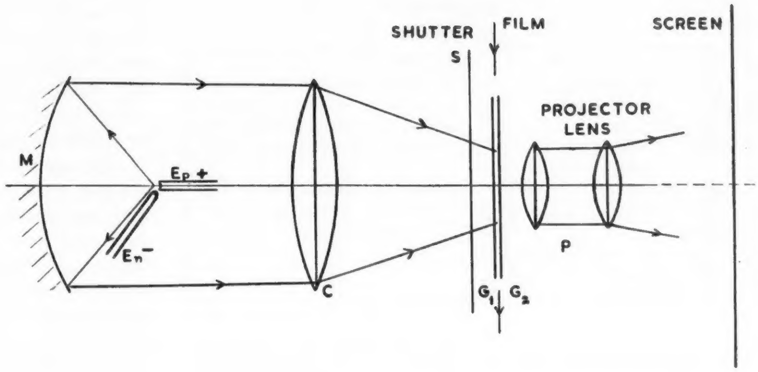

Fig. 1. Optics of typical 35-mm. film projector.

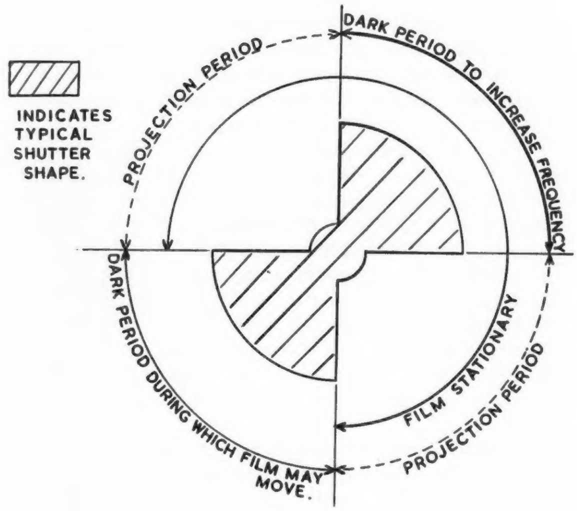

Fig. 2. Exposure cycle of shutter in carbon arc projector.

usually by 110/115-volt motor generator sets or rectifying units. The current in the arc is limited by a series resistance.

Both positive and negative electrodes are consumed during arc operation and automatic, mechanical feeds are incorporated into the arc housing both to revolve the electrodes about their axes and to feed at the rate determined by carbon burn-up. Efficient fume extraction processes need to be associated with each housing, since typical consumption rates are 6-16 in./hr. for positive and 3-4 in./hr. for negative carbons. The arc is formed by touching together the carbon electrodes and then withdrawing them apart quickly to their correct spacing.

(2.2) *Electrical and Optical Data*

In a typical medium-sized cinema the following data were measured by the author:—

Arc length: 0.8 cm.
Arc current: 60 amps.
Arc voltage: 40 volt.
Screen illumination (av.): 15 ft.c.
Screen size (picture): 18 ft. x 14 ft.
Projection throw: 75 ft.

It is of interest to consider here the approximate efficiency of utilisation. Taking a typical luminous efficiency value of 40 lumens/watt the total lumens available are 60 x 40 x 40; the illumination on the screen is 18 x 14 x 15 lumens; hence the overall efficiency is given by:—

$$\frac{100 \,.\, 18 \,.\, 14 \,.\, 15}{60 \,.\, 40 \,.\, 40} = 4 \text{ per cent.}$$

In the larger cinemas arc currents of between 100 to 180 amps are employed which, with the same approximate voltage drop in the arc, constitute loadings of up to $7\frac{1}{2}$ kw.; with higher arc voltages the loadings may be greater than 10 kw.

Typical luminance values for high-intensity carbon arcs are 50,000 to 100,000 stilb. In the cinema where the author took measurements the luminance was about 60,000 stilb. The luminance of the source in an application of this nature is of paramount importance, the higher the luminance the higher the maximum theoretical efficiency of utilisation.

The colour of the radiation approaches that of a black body at 5,000-5,500 deg. K; consequently, either black and white or colour films can be projected.

The recommended screen brightnesses both in America and the United Kingdom are as follows:—

American Standard 2.22.39-1944. "The brightness at the centre of the screen for viewing 35 mm. motion pictures shall be 9 to 14 ft.-lamberts when the projector is running with no film in the gate."*

British Standard BS 1404-1947. "For black and white film a minimum of 12 ft.-lamberts and a maximum of 24 ft.-lamberts. For Technicolor film a minimum of 7 ft.-lamberts and a maximum of 14 ft.-lamberts."

(2.3) *Principal Characteristics of Carbon Arcs*

The above section has been intended to give a brief general picture of the arc projector in order that the essential characteristics of the carbon arc for cinematograph projection can be appreciated the better. For comparison purposes these characteristics are enumerated in Table 1, chiefly with the intention of pointing the way towards a preferred light source.

(3) Possible Alternative Light Sources to Carbon Arcs

(3.1) *Tungsten Filament Projector Lamps*

Except in the case of 16 mm. film projection, the luminance of typical projection lamps at a value of some 2,000 stilb is quite inadequate for 35 mm. cinematography.

* "The measurement is made with the shutter in operation, since this appreciably reduces the screen intensity"(5).

TABLE 1
CARBON ARCS

Advantages	*Disadvantages*
High Wattage, Small source size } leading to High luminance. Light output constant with time. "Natural" colour of radiation suitable for colour or other films.	Need for fume extraction system. Mechanical feed. Constant attention required to change electrodes, etc.

(3.2) *High-pressure Mercury Arcs*

In the laboratories with which the author is associated, work has been carried out to apply high-wattage, high-pressure, short-arc mercury lamps to film projection. These lamps, ranging from 125 watts to 15 kw., have high luminous efficiencies of the order of 50-60 lm./w. and may have luminances exceeding the brightest carbon arcs; their characteristics have been fully described in the literature(6) (7) (8). Table 2 sets out principal dimensions for the higher wattage types.

Briefly, the higher wattage lamps consist of a pair of tungsten electrodes, separated by a gap of the order of 10 mm. and situated almost at the centre of a spherical, hermetically sealed, quartz envelope. Two tubular quartz/molybdenum seals, placed diametrically and radially, serve to feed current into the electrodes. Operation may occur on the same supply systems as the carbon arc. Usually, but not necessarily, the mercury arc operates vertically with the envelope in free air and requires no artificial means for cooling.

The arc requires initiation by momentarily applying a Tesla coil or some form of auxiliary high voltage at very low power; it forms between the electrodes in a residual and low pressure of a rare gas. After some five minutes, by which time the pressure of mercury vapour may have reached some 20 atmospheres, full arc brightness is achieved. If the arc is extinguished, the lamp must be allowed to cool before it can be reignited, whence a further short period of time must elapse before it is operationally useful again; specialised circuits can, however, overcome this problem(9) (10) (11).

A further physical form of lamp is of interest in that it is constructed with the seal limbs and electrodes at right angles, having a form of arc very close indeed to that of a conventional carbon arc(6).

The visible radiation from mercury even in the high-pressure condition consists chiefly of the principal lines of the element at wave-lengths of 4,358, 5,461, 5,770/91 Å, resulting in a light somewhat deficient in red. For black and white projection this is unimportant; for colour films the results, although surprisingly good, bearing in mind the quality and make-up of the radiation, fall short of the required standard : this is the principal drawback to the use of mercury. Colour quality can be improved by the addition of cadmium to the lamp envelope(12), but there is some sacrifice of luminous efficiency, luminance and life.

A limited range of super-high pressure mercury lamps, where the arc discharge is contained within a capillary bore, thick-walled, quartz tube cooled by a stream of running water, is available(6); run-up and restart times are almost instantaneous and the higher pressures (ca. 75 atmospheres) allow a somewhat better colour than occurs with the air-cooled design. The arc shape and other factors, however, have prevented any widespread consideration of the use of such lamps for cinematography although equipment incorporating them has been designed(13).

The following table summarises the properties of air-cooled high-brightness mercury lamps and should be used in comparison with the similar table for the carbon arc (Table 1).

TABLE 2
CHARACTERISTICS OF HIGH PRESSURE MERCURY VAPOUR LAMPS—UNITED KINGDOM.(7)
(1) Plain Mercury, Type ME.
(2) Colour Modified, Type MEC.

	ME	ME | MEC	ME | MEC
Rating, lamp wattage.	1,000	2,500	5,000
Supply voltage.	200/250 A.C. or D.C.	110/250 D.C. 200/250 A.C.	110/250 D.C. 200/250 A.C.
Normal operating position.	Vertical flange down	Vertical	Vertical
Average life, hours.	500	*c*.200	*c*.200
Initial efficiency lm./w.	50-55	*c*.55 | c.45	*c*.60 | c.50
Lamp operating volts.	60-75	65-80	65-80
Approx. starting current, amps.	21	50	100
Approx. running current, amps.	18 A.C. and 16 D.C.	37 A.C. and 33 D.C.	75 A.C. and 67 D.C.
Cap details.	Prefocus flange	SPECIAL	SPECIAL
Overall length, mm.	245±2.5	*c*.300	*c*.375
Arc length, mm.	5.5±0.5	*c*.7.5	*c*.9.0
Diameter, of quartz envelope m.m.	50	62.5	90

NOTE: Percentage transmission to Wratton 25 A filter for MEC lamps—approximately 10. Above 1,000-watt rating separate lamps are used for A.C. and D.C. operation. Certain types are supplied with both seals at one end of the lamp—termed "single ended."

TABLE 3
AIR-COOLED HIGH WATTAGE MERCURY VAPOUR LAMPS
COMPARISON WITH CARBON ARCS FOR CINEMATOGRAPH PROJECTION.

Advantages	*Disadvantages*
Complete cleanliness. No fumes, deposits, etc.	Unsuitable for colour films.
No associated mechanical gear.	Light cannot readily be switched in or out at full intensity.
Long life with no need for attention.	Gradual fall-off in intensity through life to perhaps 60 per cent. of initial.
Possibilities of optics re-design for improved efficiency of utilisation.	End of life not well defined.

(3.3) Xenon Arcs

(3.3.1) *Historic*

Early in 1947 a 5-kw. water-cooled arc discharge lamp containing a relatively high pressure of pure xenon was announced by Aldington(3). This lamp was shown to be capable of a life of 100 hours giving light of a sunlight quality at an efficiency of some 30 lm/w. Moreover, it could be switched in or out at any time to give full light output instantaneously. For projection purposes its maximum luminance was relatively low.

Later in the same year a 1-kw. air-cooled lamp with short arc and high luminance, in appearance not unlike a 1-kw. lamp of the type described above, was reported (14). This lamp contained a cold filling pressure of some 8 atmospheres of pure xenon.

Between 1947 and 1951 much work was carried out in the main lamp research laboratories and a summary has been given(4). Further work has resulted in more advanced types and those of a compact form suitable for the application considered here will now be described.

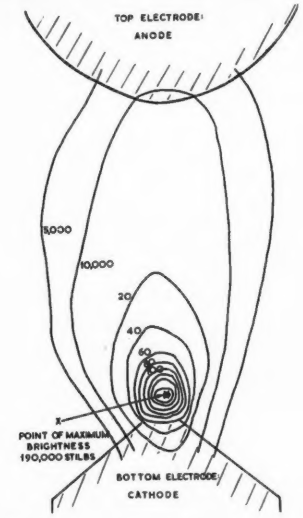

Fig. 3 (left). 2½-kw. high-pressure xenon lamp. Fig. 4 (right). Luminance distribution diagram for 2½-kw. xenon lamp.

(3.3.2) *High Brightness Xenon Lamps*

High brightness xenon lamps are of short arc type (14) (15) (16) (17); consequently in appearance they are not unlike the more familiar mercury lamps mentioned above. A photograph of a 2½-kw. xenon lamp investigated by the author is reproduced in Fig. 3.

Of the two parameters, arc current and arc voltage, the product of which gives the loading in the arc, the

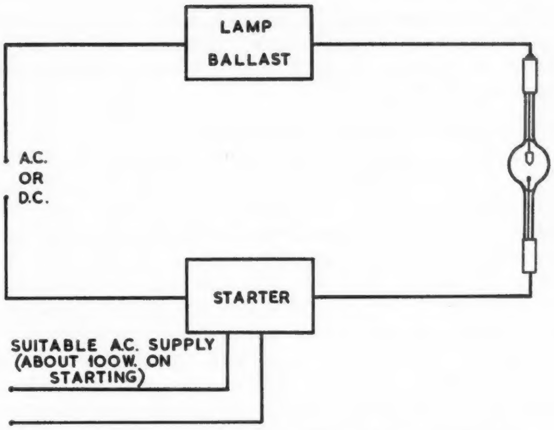

Fig. 5. Basic circuit for xenon lamp operation.

former may be considered as the independent variable. Arc voltage is almost independent of arc current and is chiefly determined by inter-electrode spacing and gas pressure, being proportional to both. In practical light sources of the type considered the arc voltage is of the order of 30 volts; a 2½-kw. lamp operates at some 80-90 amps.

Unlike a mercury lamp, the pressure in which is developed by evaporation of a small and carefully measured mass of mercury, the xenon lamp contains a permanent gas : thus to develop high xenon pressures in operation, which in turn leads to highest luminances, a relatively high cold filling pressure must be employed. Fig. 4 shows a typical luminance distribution diagram at 2½ kw. for the 3-atmosphere (cold) 10 mm. xenon arc lamp of Fig. 3. It will be seen that luminances higher than those of carbon arcs can be attained. A given loading in an arc of fixed length can be achieved in two ways (a) at relatively high current and lower pressure, or (b) at lower current and relatively high gas pressure. While a complete study of these alternatives involves many factors it is generally accepted that (a) the higher pressures involve improved life, somewhat higher average luminance and, because of lower current for a given wattage, increased efficiency of operation, and (b) the higher current design involves no danger risk due to explosion from accidental fracture of the envelope and greater arc stability, particularly on A.C. versions. Some difference of opinion exists in practical designs, and generally in the United Kingdom cold filling pressures have not exceeded 3 atmospheres while in Europe and the United States some 5-8 atmospheres are used.

Details of practical forms of high pressure, short arc

TABLE 4
PUBLISHED CHARACTERISTICS OF AMERICAN AND GERMAN SHORT ARC XENON LAMPS

	German					American			
Type	A.C.	D.C.	D.C.	D.C.	D.C.	A.C.	A.C.	A.C.	A.C.
Loading (kw.)	0.16	0.3	0.5	1.0	2.0	0.15	0.5	1.0	2.0
Arc current (amps)	8	20	25	45	70	8	28.5	57	110 (Average)
Arc voltage (volts)	21	15	20	22	28	22	19	19	19 (Average)
Arc length (mm.)	2.2	1	2.4	3.4	4.0	2.5	2.8	2.8	3.5 (Average)
Brightness (stb.)	9,000	40,000	30,000	40,000	65,000	7,000	15,000	25,000	25,000
Light output (lumens)(approx.)	3,300	6,000	15,000	35,000	80,000	—	11,000	22,000	32,000

xenon lamps produced in America have been described by Thouret and Gerung[17] and in Germany by Larché[18]. Table 4 contains German and American information published by these authors.

(3.3.3.) *Control Gear for Xenon Lamps*

Short arc xenon lamps can be designed for either A.C. or D.C. operation. Current limitation is achieved by either choke or resistance in the usual manner. Because the lamp envelope when cold carries a high gas pressure, the voltage required to strike the arc is of the order of several kilovolts; this can most conveniently be generated by a high frequency component, produced in a simple resonant spark gap circuit, superimposed on the supply voltage. Full details of typical circuits have been described elsewhere[4] [11]. The same circuit is suitable for initiating the arc under all conditions of temperature so that lamps are instantaneously available to produce full light output at any time. Normally such circuits are fully contained in a so-called High Frequency Starting Unit; the diagram illustrates the assembly of the full lamp control gear (Fig. 5).

In the case of D.C. lamps a supply voltage of 50-60 is adequate, and depending on the means of initiating the arc even lower voltages may be used. A.C. lamps generally require a somewhat higher line voltage.

It is interesting to note that active consideration has been given to the use of moving electrodes in xenon lamps as a possible means of eliminating starter devices and making the control of short arc xenon lamps even more attractively simple[19].

(3.3.4) *Comparison of High Brightness Xenon Arcs with Carbon Arcs*

From the detailed account given above of short arc xenon lamps of high brightness, Table 5 can be compiled comparing these light sources with carbon arcs for cinematography projection; it should be used in conjunction with Table 1.

(3.4) *Stroboscopic Flash Discharge Tubes*

A form of rare gas discharge lamp which cannot be overlooked in connection with cinematograph projection is the xenon-filled stroboscopic flash discharge tube[20]. The light is produced in the form of a flash of short duration by the discharge through xenon of an electrical capacitor charged to a (usually) high voltage; this can occur at any frequency and can be conveniently and easily controlled. Thus such a lamp at 48 flashes/sec. could illuminate a film twice per frame position, allowing " pull-down " between consecutive flashes and permitting the removal of the shutter: the efficiency of such a projector could thereby be increased. Although such light sources give the familiar high current xenon spectrum approaching closely to a continuum and the efficiency at 40-50 lm./w. is high, the source size has to be extended generally rather than compact—thus the luminance is not high and the overall wattage in developments to date is low. The wattage can be increased by inclusion of a series thyratron to the lamp, but the circuit complexity is thereby increased[21] [22]; however, such a system has been incorporated in a 16 mm. projector with some success[23]. A simple xenon flash tube used by the author in similar experimental work is shown in the photograph of Fig. 6; the long arc tube is bent into a flat grid to

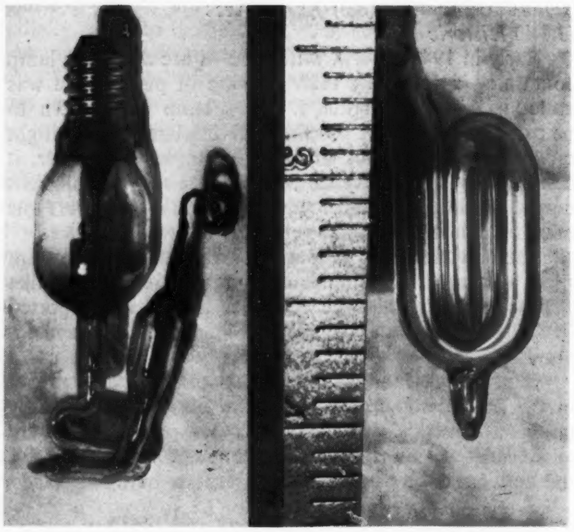

Fig. 6. Experimental stroboscopic xenon flash tube: left—general view of tube; right—enlarged view of portion of arc tube directly used for illumination.

coincide with the frame dimensions. The wattage was between 50 and 100, efficiency 35 lm./w, frequency (max.) 100 c.p.s., colour temperature 6,500 deg. K; it was capable of operation on a simple circuit using a capacitor charged to some 600 volts without the need for series thyratron control.

While it is not to be inferred that stroboscopic xenon flash discharge lamps can yet be seriously considered as competitors to carbon arcs for commercial 35 mm. film projection, it is suggested that they form an important and worthy line of possible development.

(4) Xenon Arcs and 16 mm. Film Projection

A typical 16 mm. film projector uses as the light source a 750- or 1,000-watt tungsten filament projector lamp. The total lumens available are, with a 1,000-watt lamp, 28,000 associated with a life of 25 hours. The

TABLE 5

SHORT ARC HIGH BRIGHTNESS XENON ARCS—COMPARISONS WITH CARBON ARCS FOR CINEMATOGRAPH PROJECTION

Advantages	*Disadvantages*
Medium high wattage, Very small source size, leading to	Slow but gradual lumen depreciation by bulb darkening.
	Lamp failure time not known precisely.
High luminance.	High voltage pulse start required.
Attention-free operation for long (in excess of 500 hours) operation.	Hazards of explosion (only in very high pressure types).
Instant light output at any time by remote control if necessary.	Low arc voltage tending to give lower overall efficiency on present D.C. line voltages.
" Natural " colour of radiation.	
Possibilities of increased efficiency of utilisation by redesign of optics.	

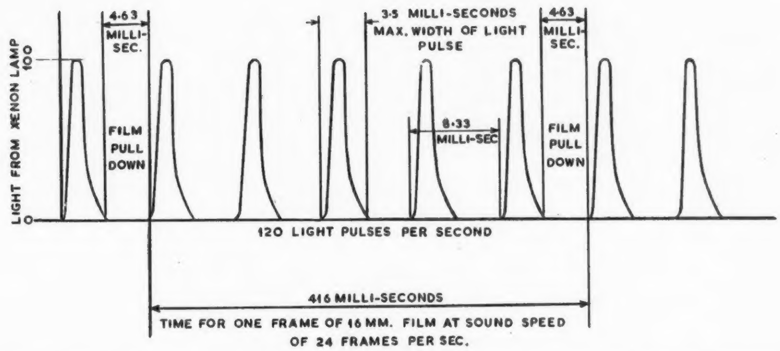

Fig. 7. Exposure and " pull-down " cycle with pulsed xenon lamp.

maximum luminance is about 2,000 stilb. Except in the relative complexity of its control gear, it will be evident from Section 3.3 that a 1,000-watt high-pressure xenon arc is superior in all respects. It is to be expected that very rapid expansion of the use of xenon arcs in 16 mm. film projection is imminent.

In this connection an important contribution has already been made in America in the announcement of a portable equipment for 16 mm. film projection for CinemaScope and 3-D optical systems(2) (24) (25). A 1,000-watt xenon high-pressure short arc lamp is operated from 60 cycle A.C. mains, using a ballast designed to give a " pulsed " form of light output such that the normal shutter can be eliminated; with a projection rate of 24 frames/sec. it is possible to obtain five light pulses and to " pull-down " between the fifth and sixth pulse. The diagram of Fig. 7 illustrates the principle fully. In the United Kingdom, where A.C. supplies are generally 50 cycles/sec., such a system would necessitate film projection at 25 cycles/sec.; this would not be a disadvantage of any serious order, and moreover is not uncommon practice for transmitting standard film by television(26).

(5) Relative Costs

It was not considered possible in a short article of this nature to give any meaningful picture of approximate relative costs of operating a typical projector on carbon arcs and xenon arcs. Many factors need to be considered. However, although a straight comparison of costs of carbon electrode versus xenon arc lamp replacements per hour can lead to erroneous deductions, it can be stated that xenon lamp costs per hour are at the present stage of small-scale production (a) roughly equivalent to carbon arcs and (b) below those of 25-hour tungsten filament projector lamps.

(6) Conclusion

Up to the present day the carbon arc has been the only light source combining the high wattage and high luminance necessary for commercial 35 mm. cinematograph projection involving both colour and black/white films. Developments in high pressure, high brightness, short arc xenon lamps have already reached a phase sufficiently advanced to enable them to be used successfully and with material improvement in 16 mm. equipment. New light sources of the required general characteristics are available at the present time to be considered as serious competitors to all carbon arcs: development work in this field is going ahead powerfully.

It is to be expected that in the near future equipment will be constructed for 35 mm. cinematograph projection, employing the more powerful xenon arcs which with new optical systems may well prove superior to conventional carbon arc designs.

Acknowledgment

This paper is published by permission of Dr. J. N. Aldington, Managing Director, Siemens Electric Lamps and Supplies, Ltd.

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Lighting for Film Production

By R. L. HOULT, F.R.P.S., F.B.K.S.*

Introduction

When, in 1947, I became engaged in technical research for film production, I took aside one of the leading cameramen in this country and asked him how he had attained his pre-eminent position. He replied: "I started by studying portraiture and the rest followed." I put his words to the test and found them to be true. They have been for me a guide to this day and I can offer no better advice to any person aspiring to become a professional lighting cameraman.

Portraiture then shall be our beginning. In many respects it is also our end, because the modern film tends to be sold on its star value, and no star gleams so brightly as when entrusted to the hands of a discriminating photographer. I have, in fact, been told that certain artistes, when engaged to star in a film, insist on the services of specific cameramen to supervise the lighting. Coming from the artiste, this may be regarded as a compliment to the photographer, but I have never heard of a producer who was so bold as to make a similar stipulation!

Requirements of Photographic Light Sources

If, then, we regard portraiture as the basis of motion picture lighting technique, we can start our study of lighting requirements in the still photographer's studio and then extend it to the motion picture studio. It is not our intention here to discuss the technique of lighting for photography as such, but rather to consider the requirements which that technique makes on artificial lighting equipment and to note how this lighting equipment is evolving at the present day.

The basic function of lighting for photography is to simulate natural lighting conditions. A studio portrait is therefore so lit as to conceal the fact that it was ever made in a studio. Sunlight, open or shaded; firelight; moonlight; a room interior, by night or by day; at the seaside or at the theatre; these are representative situations which the photographer seeks to infuse into his subject. Backcloth and props alone do not suffice. His principal medium is artificial light, which for practical purposes must be manoeuvrable, controllable and stable, besides possessing appropriate spectral characteristics when required for colour reproduction. Lighting may be "hard" (emanating from a small source) or "soft" (emanating from a broad source). It may be continuous or intermittent (as for flash-light photography). It may be intense (at levels approaching sunlight) or subdued, for low-key effects and shadow-filling. All these requirements have been with us for 50 years or more. To-day a new principle is being introduced into the design of lighting equipment—that of providing a consistent and appropriate spectral composition, in order that the same equipment may be used for either monochrome or colour photography.

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Especial Needs of Colour Film

Some considerations on this subject have already been described in this journal (September, 1954, p. 253) and in the journal of the British Kinematograph Society (British Kine. **24,** 72 (1954). The upshot of these considerations is to show that modern lighting practice has to accommodate two different colour temperature levels, *viz.*:—

1. "Daylight" or "White light."
2. "Artificial light" or "Incandescent."

These two levels are characterised respectively by colour temperatures within the following ranges:—

1. 5,000-7,000 deg. K.
2. 2,800-3,400 deg. K.

One object of the above-mentioned two papers was to propose standards for these two colour temperature levels. But even without standards, these two levels still exist, and for each level there are available appropriately sensitised types of colour film. The object of manufacturers is therefore to provide both colour film and lighting equipment appropriate to either or both the above levels.

Within any one level the cameraman still wishes to select his lights according to their other characteristics. He needs sources of high power and sources of low power. He needs hard light and soft light. He needs economical, efficient, cool, easily handled equipment. He wants to use it on floor stands or slung from overhead supports. He wants to be able to add diffuses, filters, "barn doors" and shutters in front of any light at will. He wants to know that having adjusted a lamp to a certain axial candle-power, it will remain stable while he attends to other lamps and finally shoots the scene. He also wants to be able to change his "technique" (i.e., colour temperature level) from set-up to set-up at short notice. For this purpose every lamp must be capable of operating at either of two colour temperatures. In

Fig. 1. Type 170 *H.I. arc* (150-*amp.*).

Fig. 2. Type 414 *Incandescent spotlight* (5-*kw.*).

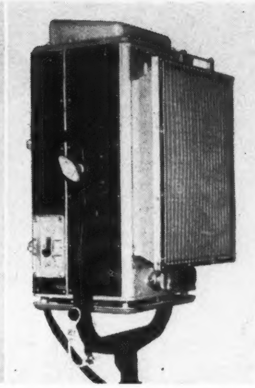

Fig. 3. Type 40 *Du-Arc.*

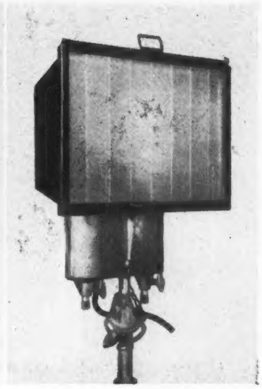

Fig. 4. Type 20 *Incandescent floodlight* (2 x 1,500-*watt*).

(By courtesy of Mole-Richardson (Eng.), Ltd.)

practice, this is effected by the addition of appropriate blue or orange C.T. filters to the lamps themselves and possibly also to the camera.

This continual changing of "technique" in colour-filming is largely prompted by considerations of economy and ease of operation. Thus, a small intimate scene in which the dialogue is important will generally be lit by incandescent tungsten lamps, which are compact, silent, emit no smoke and need little attention. The lower C.T. level would probably be chosen because with the appropriate film stock no filters would be needed and an economy would be achieved. On the other hand, a large set which has perhaps to be lit to reproduce sunlight or moonlight would require hard lighting, for which purpose carbon arcs are most suitable. For such a set it would be most economical to use "daylight" film or to filter the camera, and to light the set at the higher C.T.—again without the need for filters on the lamps. Other types of set would represent intermediate conditions, and in some cases the choice of technique would be arbitrary, governed by previous arrangements to avoid making unnecessary changes in the lighting rig.

Special Photographic Effects

Besides wanting to reproduce Nature exactly, the cameraman may often have occasion to introduce a little exaggeration. Thus, moonlight is traditionally represented as much more blue than it really appears, and the glare from a fire as much more red. Again, strong colour effects are used in dance sequences and for the treatment of phantasy. For these occasions various types of colour gelatine or acetate filters are used in conjunction with the individual lights. Attempts to manufacture lamps with a variable colour output have not so far been successful. There does not seem to be a very strong case for such equipment, while for economy and ease of handling the expendable colour filter is hard to beat.

Coloured Filters for Lamps

Coloured filters have long filled this specialist role, and of late have also been used for raising and lowering colour temperature to match the lamp to the type of film stock in use. The economy of these filters depends on their stability and life, two properties which in the past have received insufficient attention from manufacturers. The manufacturer of the filter material itself can assist by incorporating only those dyes which are both stable to light and heat, and which are photometrically efficient and matched to the response curves of colour film. The manufacturers of the lamp can assist by providing mounting brackets which allow an adequate unimpeded current of air to circulate between the filter and the lamp housing—a necessary factor in obtaining a reasonable life under practical conditions.

Lighting Equipment for Outdoor Use

A few words may also be said about the use of artificial lighting equipment outdoors.

Every climate imposes different problems on the cameraman outdoors, but for motion picture production he will always need artificial light to supplement natural daylight. It may be that there is no sun shining, when he will use powerful arcs to replace the sunlight. Or it may be that the sunlight is intense, when he will still need powerful lamps to illuminate the shadows. It is, however, obvious that supplementary lighting of this type must operate at the higher C.T. level, since it is used in direct combination with daylight. Moreover, to reinforce the sun requires lamps of high power, and it is in this role that the high-intensity carbon arc is used almost exclusively.

A natural supplement to outdoor lighting equipment is the reflector—either specular or matt—which is used to reflect light into areas of shadow. Because reflectors are associated so closely with lighting equipment they are stored and handled by the same members of the electrical department. Reflectors have also been used for set lighting on stages, but their application to this role is not very widespread.

Mixed Lighting on Location

A further development of the use of artificial light to reinforce daylight concerns shooting in buildings, vehicles, etc., which are largely illuminated through windows by daylight from outside. In such places it is not

Fig. 5. A set from the film "As Long as They're Happy" produced at Pinewood Studios.

(By courtesy of Group Film Productions, Ltd.).

Fig. 6. A setting from the film "Romeo and Juliet" whilst on location in the Basilica of St. Zeno, Verona, Italy.

(By courtesy of Verona Productions, Ltd.).

always possible to introduce arcs, either on account of their size or their weight, or because of the smoke they produce or simply because of the cost. In such cases it is possible to proceed as follows. The windows are covered with sheets of orange C.T. reducing filter material and supplementary light is provided by incandescent lamps. The film stock of course is balanced to the incandescent level. This technique is particularly useful in moving vehicles and for impecunious film producers generally.

Types of Artificial Light Sources

Of the many different types of artificial light source available at the present day, the most practical and generally used in motion picture studios are the following:—

1. High-intensity carbon arcs.
2. Incandescent tungsten lamps.

These two types of source are both available as spotlights (focusing, for the production of hard light) and floodlights (non-focusing, for the production of soft light). Typical spots are the Mole-Richardson type 170 High-Intensity Arc (150 amps) and the type 414 Incandescent Spotlight (5 kw.), shown in Figs. 1 and 2. Typical floods are the Mole-Richardson type 40 " Du-Arc " and the type 20 Incandescent Floodlight (2 x 1,500 watts), shown in Figs. 3 and 4.

Several other manufacturers supply similar types of lighting equipment, but those mentioned above are typical and hold a well-deserved place for their rugged, clean and practical design.

The uses to which lamps of this type are put are illustrated in Figs. 5 and 6, which were taken from recent productions. These figures show, respectively, a small intimate set lit for colour photography by incandescent spots and floods, and a large location setting lit by carbon arcs, also as spots and floods.

Discharge Lamps

Following the 1939-1945 war, some attention was paid to the development of compact-source mercury-cadmium lamps, both as spots and as floods. Although accepted for certain roles by Technicolor Ltd., they never enjoyed great popularity—principally on account of the high cost of replacing the bulbs and also because of their imperfect colour quality. It seems very doubtful whether a spectral composition adequate for the exacting standards of colour photography will easily be obtained from gaseous discharge lamps, unless some new principle be discovered which will permit a more satisfactory blending of broad spectral bands of blue, green and red. It is also necessary that the emission envelope should correspond to the sensitivity envelope of modern three-colour film—for example, as shown in Fig. 7. No other condition will give both satisfactory colour rendering and a visual match of colour.

Film Speeds and the Future

For the future, conflicting prospects are with us. On the one hand there is an insistent demand for more powerful lamps—the object being to keylight a whole set from a single source. On the other hand there is the continual increase in the speed of film stock (and in the sensitivity of television tubes).

We have already seen a drop in the mean illumination level for colour filming, of the order of 50 per cent. since the last war. Whereas in 1946 the Technicolor process required a keylight of at least 1,000 ft.c. (of H.I.

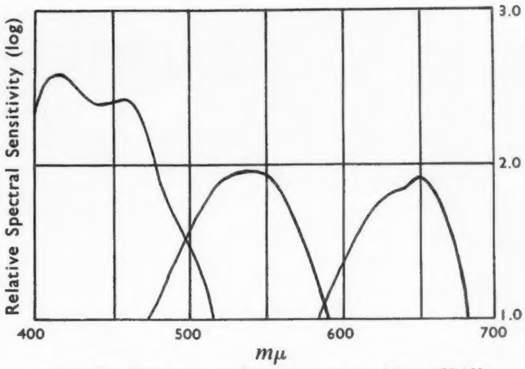

Fig. 7. Eastman colour negative film (5248).
(By courtesy of Kodak, Ltd.).

Arc-light) at f/2.8 for satisfactory results—to-day the corresponding level is about 600 ft.c. at the same colour temperature. A similar level can also be used with Eastman Colour Negative in conjunction with the appropriate camera filter. How far this progression will be maintained it is difficult to say, but it is quite possible that the next five or 10 years may see existing levels cut again by some 50 per cent.

These increases in film speed do not always bring corresponding reductions in illumination level. Cameramen have another conflicting requirement—to shoot at the smallest reasonable lens stop to secure the maximum depth of field. Consequently, the present day sees a fairly stable level in use of some 400 ft.c., a compromise between securing adequate depth of field and imparting an economic limit to the lighting requirements. It is quite possible that a doubling of film speed will be accompanied by a reduction in the lens aperture of one stop, thereby significantly increasing depth of field and leaving the mean illumination level at its present workable value.

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Frontispiece

The picture on page 157 shows the smoke-room on the new Shaw, Savill liner Southern Cross in which over 100 12-in. G.E.C. architectural lamps are used. Indirect lighting by reflection from the highest part of the domed ceiling is provided by 32 of these lamps concealed in a cornice which forms a 9-ft. diameter circle. Similar lamps are used in two flush panel fittings in the window bays, each with 19 lamps of the 12-in. size, and in seven ceiling fittings, of which four, measuring 8 ft. by 8 in., contain seven lamps and three (6 ft. by 8 in.) contain five lamps.

A circle 22 ft. in diameter is formed by a glazed frieze fitting immediately below the dome cornice lighting, and is illuminated by 96 25-watt general lighting service lamps. Around the perimeter of the ceiling there are two circles of 10½-in. diameter recessed ceiling fittings with stepped lens glasses, for 40-watt or 60-watt lamps. Two 15-in. dia. recessed fittings are mounted in the alcoves at each end of the smoke-room. These accommodate three 60-watt lamps, and the glass is sand blasted with a pattern of concentric circles.

Lighting Abstracts

LIGHTING

628.971

152. Football in artificial light.

N. EIDERMAN, *Ljuskultur*, **26**, 102-105 (*Oct.-Dec.*, 1954). *In Swedish.*

The different requirements of spectators and players must each be given proper consideration. This means that the lighting standards must be placed differently depending on whether or not there are raised standards for the spectators. A description of a 117-ft.-high mast is given. R. G. M.

628.972

153. New installations and the season's lighting fittings.

ANON. *Ljuskultur*, **26**, 88-92 and 97-101 (*Oct.-Dec.*, 1954). *Photographs with captions in Swedish.*

Examples of shop lighting including a luminous ceiling system, a spinning room with an artificial " starlight " roof lighting system, and some new decorative schemes with simple fittings. The new fittings are mostly typically Scandinavian, with clean lines. A large pendant unit, consisting of 88 crystal-glass reflectors each with a 40-watt clear miniature lamp, is shown. R. G. H.

628.971.6

154. Recent new public lighting installations in the City of Bordeaux.

M. DUFOURQ, *Lux*, **22**, 120-123 (*Dec.*, 1954). *In French.*

New street lighting in Bordeaux uses to date some 1,000 new lanterns with type MBF new high-pressure mercury lamps with fluorescent outer jackets. Tests were first made with several types of lantern with type MCFU tubular fluorescent lamps, some parallel to the street axis and some normal, with both instant-start and starter circuits, as well as with the type MBF lamps in ellipsoidal reflector lanterns. The latter had advantages in better appearance, ease of cleaning and relamping, simple maintenance and painting, and long life of the lamps; 8,000 hours' life was obtained at first, which later dropped a little. A typical installation had an asphalt surfaced carriageway 13 m. wide with parking space and footways with trees at the sides, giving 31-m. width between building lines. Existing columns were used at 40-m. spacing, opposite arrangement and 9-m. mounting height; each carried two 125-watt MBF lamp lanterns, with ellipsoidal aluminium reflectors, one directed to the carriageway and one to the footway. Auxiliaries are housed in the lantern. Average illuminations of 9.5 lux were obtained on the carriageway and 11 lux on the footway, an improvement of six to seven times on the old lighting with half the energy consumption. Other installations are described. The Pont de Pierre, which is 18 m. wide to parapets, is lighted by 7-m. columns mounted on the parapets, carrying slightly conical lanterns with opal plastic envelopes, 1.50 m. high to the finial, each with four type MBF lamps, 125-watt, arranged one above the other and each with a circular aluminium reflector. Auxiliaries are housed in a box in the base of the column. J. M. W.

628.971.8

155. Lighting of the Pont des Ardennes, Namur.

ANON. *Lux*, **22**, 126-127 (*Dec.*, 1954). *In French.*

The new Pont des Ardennes is a particularly slender structure on which columns would obviously be out of place. The bridge is 205 m. long and 20 m. wide to the parapets. Lighting has been arranged in the parapets; 30- and 40-watt fluorescent lamps are arranged with aluminium trough mirrors, a horizontal louvre and clear plastic flat glazing. Auxiliaries are carried in the parapet behind the mirror. Access is arranged by opening the cast top. The interior is sealed when the top is closed. Earlier experiments had showed that lighting by low-mounted projectors emitting light either towards or away from the traffic was unsuccessful. The present arrangement with continuous lines of sources casts no perceptible shadows, causes very little glare and illuminates objects on the bridge from all sides. An illumination of 30 lux is obtained on vertical surfaces in the middle of the bridge. Three hundred and five 40-watt lamps are used and the total loading is 14.6 kw., including losses in auxiliaries. Half lighting can be obtained by extinguishing alternate lamps. J. M. W.

621.327.4

156. Lighting of traffic under-passes and tunnels.

E. VON DER TRAPPEN, *Lichttechnik*, **6**, pp. 427-432 (*Dec.*, 1954). *In German.*

The author refers to experiments carried out in a model tunnel before the war. He emphasises the need for a high illumination of the initial portion of a tunnel and suggests a gradual diminution from 250 to 7 lm/ft^2 over a distance of 70 metres from the entrance. Since the daylight illumination may well be 1,000 to 2,000 lm/ft.^{2} the provision of, say, 10 lm/ft^2 of artificial illumination is quite useless. Sodium lamps are, generally, the most convenient and economical. As regards the arrangement of the light, the greater part may well come from above, but some should come from the sides as well. The paper concludes with some details of the lighting of a number of tunnels outside Germany. J. W. T. W.

628.971.6

157. Economics of mercury lighting for industrial areas.

W. H. JOHNSON, W. H. KAHLER and D. W. ROWTEN, *Illum. Engng.*, **49**, 575-583 (*Dec.*, 1954).

Discusses the economics of five types of mercury vapour lamp in relation to those of fluorescent and incandescent-tungsten lamps, when employed in a typical high-bay industrial lighting installation. On the basis of initial cost the high wattage (1,000-watt and 3,000-watt) mercury systems were most favourable because a minimum number of luminaires were required, whereas the fluorescent systems were least favourable due to the greater number of luminaires and the lower coefficients of utilisation obtained. With high lumen sources (mercury and incandescent) the cost of lamp replacement was by far the largest factor influencing maintenance costs. With the fluorescent system, however, cleaning cost was a large factor because so many luminaires were required. On the basis of annual overall cost, the fluorescent and incandescent systems were approximately the same and were considerably higher than any of the mercury systems. High wattage mercury lamps had the lowest overall cost. In addition to the above analysis a comparison is made between the coefficients of utilisation of luminaires using mercury, fluorescent (colour-corrected) mercury, fluorescent and incandescent lamps. A comparison is also made of the relative economics of mercury, fluorescent mercury, mercury combined with incandescent and incandescent lamps alone. Circuit details are given for operating mercury lamps singly or in pairs from low (120 volts) and high (265 and 460 volts) voltage supplies. P. P.

Lighting Practice in Japan

A hotel lobby

A review dealing with lamps, luminaires, lighting standards and lighting installations in Japan.

If the average reader of this journal was asked about contemporary lighting practice on the Continent he could, provided his memory did not fail him, talk with authority about the floodlighting of the Palace of Versailles, the interior lighting of the church of Santa Maria Maggiore or the fluorescent street lighting in Madrid. If he also reads this journal's American counterpart, "Illuminating Engineering," he could equally well expound on lighting developments and techniques in the United States.

It is more than probable though that if asked the same question about Asian countries he would be at a loss for an answer other than to recall pictures he had seen of lighting for special occasions, such as the Coronation illuminations in Hong Kong. The average reader's knowledge is likely to be even more scant if the question was to refer to a country so remote as Japan, where he may imagine that the sole form of artificial lighting is the Chinese (or should it be Japanese?) lantern. For those readers who have already scanned this journal, the photographs illustrating this article will have rapidly dispelled this illusion.

Just recently some information on contemporary lighting practice in Japan has been made available by Professor Y. Fujiwara, of Tokyo University, in collaboration with M. Minagawa and T. Saito. This information is not by any means comprehensive, and consequently it is not possible to obtain from it a complete picture of contemporary Japanese lighting practice. On the other hand there is sufficient material available from which to compile the details given in the following pages.

Range of Available Lamps

The range of G.L.S. lamps available in Japan is at least as comprehensive as it is here or in the United States. Between 10 and 60 watts the ratings are spaced at 10-watt intervals, so giving four lamps (10, 20, 30 and 50 watts) which are unfamiliar to us.

The lamp sizes are, in general, either smaller than both their British and American equivalents, or are intermediate between them. The 60-watt lamp approaches very closely to its British equivalent, having the same length and bulb diameter as the amended (1952) B.S. specification.

At a first glance it would appear that Japanese lamps have a superior luminous efficiency. They are rated at 110 volts, however, so that when comparisons are made with British and American lamps having identical operating characteristics, the Japanese lamps no longer have quite such a favourable performance.

Where lamps are common to both the British and Japanese range of wattages then their rated lives are found to be the same (1,000 hours). Three of the smaller wattage lamps (10, 20 and 30 watts), which have no British equivalents, have, however, rated lives as much as 1,200-1,500 hours.

The five available sizes of straight hot-cathode fluorescent lamp cover the range from 10-40 watts with no fewer than four lamps in the range from 10-20 watts. A circular lamp of 30 watts rating is also available.

Three of the straight lamps, 15-, 20-, and 40-watt ratings, appear to be identical with standard American equivalents. Since the range of available colours also bears a strong resemblance to the American range, it is evident that the development of the Japanese fluorescent

lamp industry has been influenced by American technology. This is, of course, to be expected in view of that country's contribution towards the economic recovery of Japan since the war. It is interesting to note though that luminous efficiencies for fluorescent lamps, comparable with those obtainable in the United States, have not yet been achieved, possibly due to a lack of more recently developed high-efficiency phosphors.

The first use of fluorescent lamps in Japan dates back to 1940, when 80 lamps were used to illuminate the murals in the Golden Hall of Horyuji Temple while they were being copied. The artist concerned is recorded as having said, "I was intoxicated and brought into self-forgetfulness for a while by an artistic atmosphere originated by white tender illumination on the mural paintings," which is as good an unsolicited testimonial as any lamp manufacturer could wish from a modern Confucius.

In the immediate post-war years difficulty was experienced in operating fluorescent lamps owing to the low supply voltage available from the war-damaged electricity distribution system. This has since been remedied and the system is now able to cope with the ever-increasing quantities of fluorescent lamps coming from the reconstructed lamp factories. The popularity of fluorescent lighting in Japan has now become so great that not only is it being installed in new and repaired buildings, but shops and offices are changing to this form of lighting as a matter of course. An interesting use to which fluorescent lighting was put immediately after the war was for insect trapping, blue-coloured lamps being used for this purpose and materially contributing to the increase in the nation's harvest in this way.

Standards of Lighting

The only guidance on standards of artificial lighting in Japan which can be obtained from the information at hand is a table of levels of illumination recommended for various locations and types of task. The table is headed "Good Current Practice," and presumably refers to values which experience and economic considerations have shown to be desirable for different kinds of work.

The layout of the table is very similar to that given in the American I.E.S. Lighting Handbook and suggests that either the Japanese recommendations may in some way be based on their American equivalents or that the Handbook data have been used to facilitate the translation into English. Certainly the illumination levels themselves have not been copied from the American recommendations, since in very few cases are the Japanese recommended levels as high as their American equivalents. More often than not the recommended levels are expressed as a series of ranges, each intended to embrace all the kinds of task applicable to a given situation, and it is found that the recommended levels given in the British I.E.S. Code usually fall within these ranges. In the case of workshops, where the degree of severity of the visual task has been graded (viz., extra fine, fine, etc.), recommendations are given for the levels of both general and local lighting.

No mention is made in the available information to any limitations which are imposed on luminances or luminance ratios, so it is difficult to judge whether or not attention is merely given to the level of illumination on the work. Similarly no indication is given of the

Fig. 1. 30-watt circular fluorescent luminaire with diffusing panels of Japanese mulberry paper.

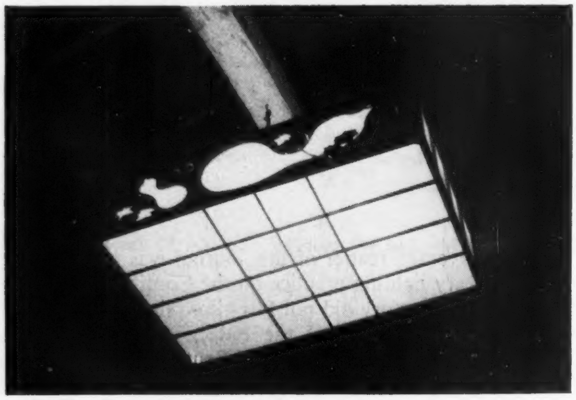


Fig. 2. Fluorescent luminaire made of wood and paper.

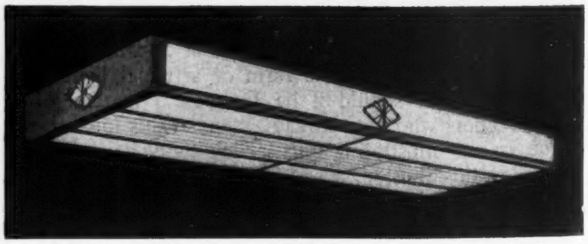


Fig. 3. Ceiling mounted fluorescent luminaire with diffusing panels of paper.

Fig. 4. Modern light sources used in a modern Japanese interior.

implementation of these recommendations in terms of Factory Acts or School Building Regulations. The picture of Japanese artificial lighting is therefore somewhat incomplete in this respect.

Luminaire Design

As in other countries, the relative influence of appearance and function on the design of a luminaire is determined to a large extent by the use to which the luminaire is to be put. For this reason Japanese luminaires intended for industrial use are primarily functional and differ little from their counterparts in other countries. On the other hand, Japanese luminaires intended, say, for domestic use differ in a number of respects from equivalent British luminaires since they are used in entirely different surroundings.

Most Japanese dwellings are made primarily of vegetable fibres such as wood, bamboo, rush mat, paper, etc., and are inevitably of relatively delicate construction. Consequently domestic luminaires are themselves lightly made, usually from the same or some similar materials so as to be in harmony with the rest of the dwelling. The interior surfaces of Japanese houses tend to be of a low reflection factor except where relieved by sliding doors or screens made of paper. The luminaires must, therefore, have a large component of downward flux, since little use can be made of upwards or sideways directed flux.

A modern pendant luminaire which conforms to these requirements is shown in Fig. 1. Here a 30-watt circular fluorescent lamp has been used, the luminaire itself comprising a light metal framework supporting panels made of translucent Japanese mulberry paper. To provide for lamp replacement the luminaire is capable of being separated into two halves.

Another pendant luminaire designed for a Japanese-style home is shown in Fig. 2. Here again the translucent material is paper, but this time the frame is made of wood.

The ceiling-mounting luminaire shown in Fig. 3 contains three 40-watt fluorescent lamps and at a first glance looks little different from equivalent British or American luminaires. The diffusing panels in the sides and bottom are, however, made of paper. The middle section of the bottom is louvred to provide the necessary component of unobstructed downward flux. It is apparently a feature for the Japanese to decorate luminaires of this type with the traditional symbol representing their particular household.

Forty-watt luminaires, with any number up to four

Fig. 5. A Japanese-style dining-room with a recessed fluorescent luminaire.

Fig. 6. A Japanese-style restaurant with fluorescent luminaires made of glass fibres.

fluorescent lamps, are now so widely used in Japan that the chassis for the control gear is made to a common design for every manufacturer. Provision is made for easy changing of the luminaire proper and for a choice of type of mounting or suspension, while the chassis are such that they can be used singly or made up into continuous troughing.

Lighting Installations

An examination of the jeweller's shop interior shown in Fig. 4 would leave one in doubt whether the photograph was taken in Bond Street or Fifth Avenue. The picture has been deliberately chosen, however, to demonstrate that in fact the Japanese are equally capable of using modern light sources in a modern interior. A number of 100-watt incandescent accent lights are used to supplement the fluorescent lighting and bring out the lustre in the jeweller's wares, so preventing the flatness which would otherwise be present if the lighting was provided solely from the louvred ceiling. An average illumination level of 48 lm/ft^2 is obtained on the display counters in this installation, with 53 lm/ft^2 on the show cases.

In a review article of this kind no advantage is gained by describing a multiplicity of this type of installation since the reader will already be familiar with many installations in this country which bear resemblances to the one just described. Quite a number of lighting installations designed to this standard now exist in Japan, however, and offer a serious challenge to the Western lighting engineer.

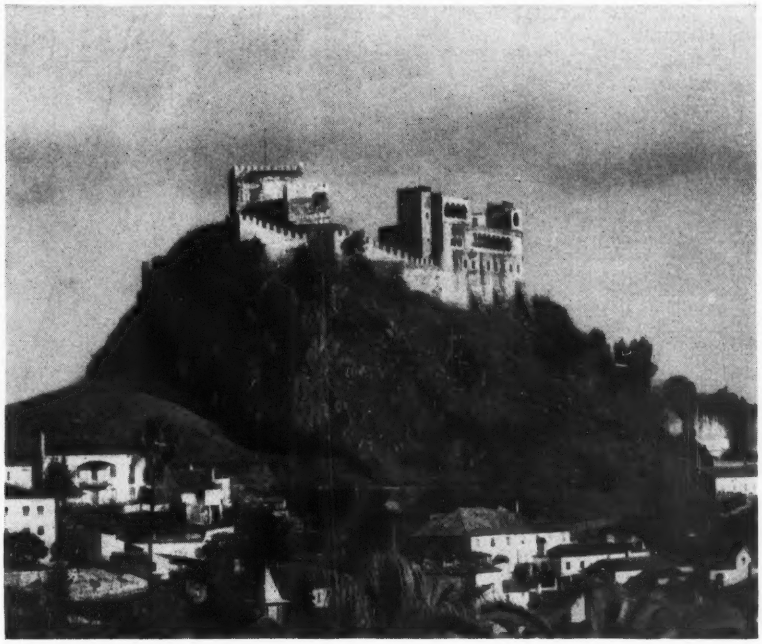
The lighting installations shown in Figs. 5 and 6 are of more particular interest in that they illustrate attempts which have been made to adapt a modern light source to Japanese-style interiors. Fig. 5 shows the dining room in a Japanese dwelling lit by three 40-watt fluorescent lamps recessed into the ceiling. By using cypress wood for the louvre system the employment of characteristic Japanese materials is maintained. The picture hanging in the alcove is lit by a single 20-watt fluorescent lamp concealed behind the transom. The illumination in the room is of the order of 4 lm/ft^2, and is said to produce the desired effect of a "calm atmosphere."

In Fig. 6 is shown one corner of a Japanese restaurant. Here the lighting is provided by pendant luminaires each containing 40-watt fluorescent lamps. Instead of the luminaires being made of mulberry paper the diffusing material this time is a white glass fibre presumably impregnated with resin. This material has the advantages over paper of a higher transmission factor, the ability to be moulded into curved shapes and, by no means least in a luminaire, non-inflammability. The installation shown also gives an average illumination of 4 lm/ft^2.

It is perhaps of interest to note that in neither of the two installations just described do the illumination levels come up to those recommended for good current practice in Japan. For instance, none of the recommended levels for dwellings are less than 10 lm/ft^2, while in hotel dining rooms and in restaurants the recommendation is for 5-10 lm/ft^2. Certainly the illustrations give the impression of illumination levels higher than 4 lm/ft^2, which suggests that perhaps a factor of 10 has been lost in the course of converting the original Japanese unit via the lux to the lm/ft^2.

In concluding this review it should not be necessary to remind the reader that the picture described here probably represents only a very limited aspect of the whole of present-day Japanese lighting practice. However, this article will at least have served to demonstrate that the Japanese are fully conscious of modern illuminating engineering techniques and are ready to adapt them to the particular needs of their own country's architecture and way of life.

Floodlighting of Leiria Castle, Portugal



Some 74 miles north of Lisbon is Leiria, the ancient capital of Portugal. The town, an ecclesiastical, military, judicial and commercial centre, is dominated by the towering grey granite mass of the castle, which some seven centuries ago saw the picturesque scenes of the ceremonial courts held by the Kings of Portugal. The castle, set some 700 ft. above the town on a precipitous pinnacle, was in olden days a royal citadel enclosing within its walls a royal palace, a chapel and the inner fortress. The castellated outer wall is pierced by a fortified gate, and includes in its fabric the bell tower. Although much skilful restoration work has been undertaken a number of buildings are now roofless.

Last autumn the 700th anniversary of the courts was commemorated, and in connection with these ceremonies an inquiry for floodlighting part of the castle was received by the General Electric Co., Ltd., from the Engineering Company of Portugal. It was accompanied by a number of daylight photographs, in which the effect of light and shade from the strong sunlight showed clearly the shape of the various buildings and their relationship to each other.

It was decided to attempt to reproduce with the floodlighting a coherent effect similar to that given by sunlight. Installation of the units in approximately their correct positions was carried out by the Leiria City Council under the direction of the chief engineer, Sn. Grenado, but to make the final adjustments a member of the G.E.C. Illuminating Engineering Department was sent specially to Portugal. This adjustment was greatly simplified by the provision of radio communication by the local military authorities, enabling instructions to be passed to the site from observation posts up to a mile from the castle.

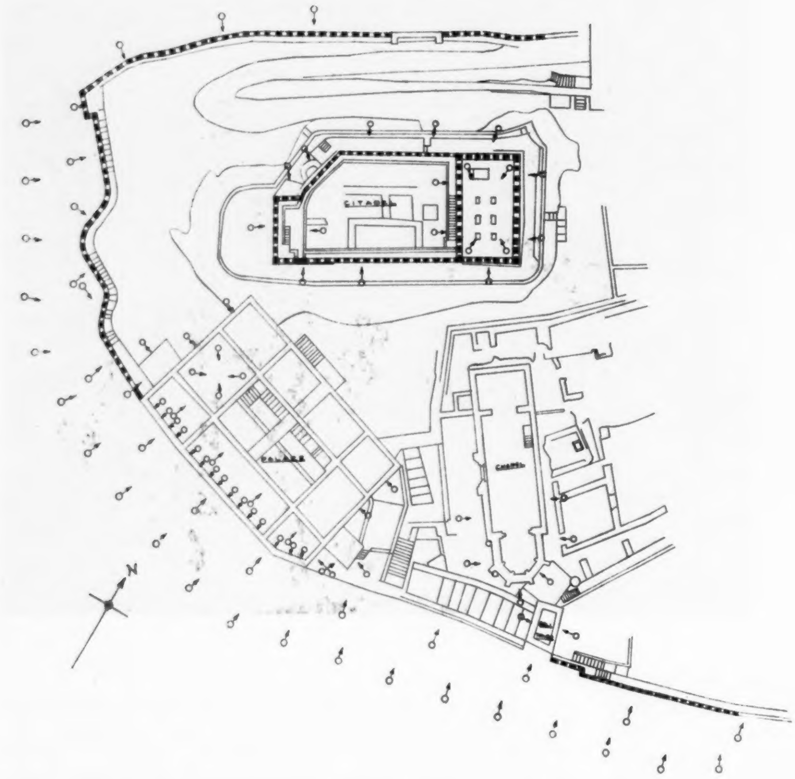
Tungsten floodlights were used to reproduce the sunlit surfaces, and mercury units to simulate the shadows. The floodlighting of the hill on which the castle stands was carried out with 400-watt mercury lamps in units mainly mounted on steel posts to avoid being masked by the low shrub growth which covered the slope. Two 10-m. (33 ft.) poles and one 14-m. (46 ft.) pole were used to raise some of the units above a group of trees growing at the base of the hill.

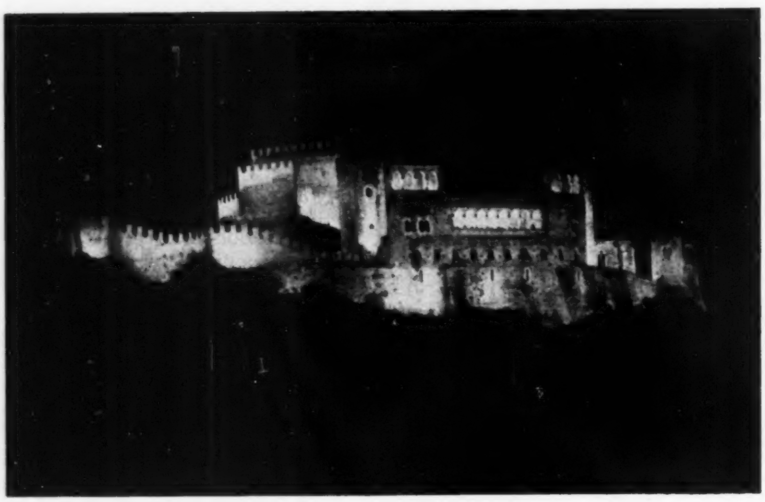
The outer wall was lit for the most part with floodlights equipped with 1,000-watt Class B.1 projector lamps. These units were mounted some 5 m. (16 ft. 6 in.) from the wall, and, due to the ground falling away steeply, some 2-3 m. (6 ft. 3 in.-9 ft. 9 in.) below it. The north-west section of the wall, and two bends in it to the south-west, were lit with 400-watt floodlights to emphasise their shape.

The palace, with its three massive buttresses, forms part of the outer wall, and its main façade was lit by three of the floodlights which formed part of the wall installation. This building has a roofed gallery, the arched windows of which overlook the town. On to each window was trained a floodlight with a 150-watt G.L.S. lamp. The fittings were mounted on the floor of the gallery, and being directed upwards and outwards on to the underside of each arch caused them to stand out very brightly against the lower brightness of the palace wall.

Four 250-watt mercury units were arranged to light the back wall and roof of the gallery, which thus formed a blue background to the tracery of the windows. By illuminating the two towers flanking the main body of the palace to a different brightness, an arresting stereoscopic appearance was given to the entire building.

The bell tower to the east of the palace also forms part of the outer wall, and its outer face was lit by a 1,000-watt floodlight with a B.1 projector lamp. To emphasise its shape a 500-watt tungsten projector lamp





unit was used on the north-east face, and a 400-watt mercury unit on the south-west face. This tower also has arched windows, the undersides of which were picked out from within by the spill light from a floodlight equipped with a 1,000-watt angle-burning lamp, arranged to shine straight upwards on to the ceiling of the tower.

The architectural details of the chapel were clearly shown under the mixed mercury and tungsten floodlighting, the former being directed from the south-west and the latter from the south and south-east.

There is a natural reduction of brightness towards the top of a vertical surface floodlit from its base. In planning the complete installation it was desired that the citadel, which is the highest part of the castle, should stand out above the rest. This effect was successfully achieved by lighting the base of the citadel brightly so that it was seen behind the silhouetted tops of the walls of the lower buildings. Four projectors were used on the flag mast to ensure even illumination of the flag no matter in which direction it might be streaming.

The total load of the installation was 48.1 kw., of which 33.65 kw. was tungsten and 14.45 kw. mercury lighting. Fifty-eight tungsten floodlights and 37 mercury units were used in the scheme.

Lighting a Pharmaceutical Factory

By P. D. FIGGIS*

Fig. 1. Exterior of factory.

An unusual fluorescent lighting installation which will eventually consist of over 3,000 fluorescent fittings is being installed in Smith and Nephew's new factory at Neptune Street, Hull, where "Elastoplast" and other pharmaceutical and surgical products are made.

The new building is being built in stages on the site of an earlier building by clearing a section at a time, and will eventually occupy a complete city block between Neptune Street and Tadman Street.

The products of the factory must be manufactured under the most hygienic conditions, and this has had an important influence on the design of the building.

The ground floor of the new building houses the receiving and dispatch departments, and a large area is set aside for storage. The works areas and offices are located on the first, second and third floors.

The building includes many novel features, the most important of which is a central service duct to each floor capable of accommodating all the services, e.g., lighting, heating, ventilation, power, water and other supplies.

It has been the consulting engineer's aim to produce as clean a working area as possible, and to this end false suspended ceilings are incorporated throughout the works area and great thought has been given to the exclusion and prevention of dust collection. It was decided to use fluorescent lighting fittings mounted flush to the suspended ceilings and made as dust-tight as possible. The specification for lighting units required the special design and manufacture of vitreous enamelled reflectors to be housed in the special aluminium extrusions which formed the runners for the suspension of the ceiling board.

Single 80-watt fluorescent lamps were chosen as being the most efficient and economical to produce the desired level of 20 lm/ft^2 throughout the factory area, and six such fittings are used in each 20-ft.-square bay, positioned in two rows of three.

The control gear for each row of reflectors is mounted

* Lighting Department, British Thomson-Houston Co., Ltd.

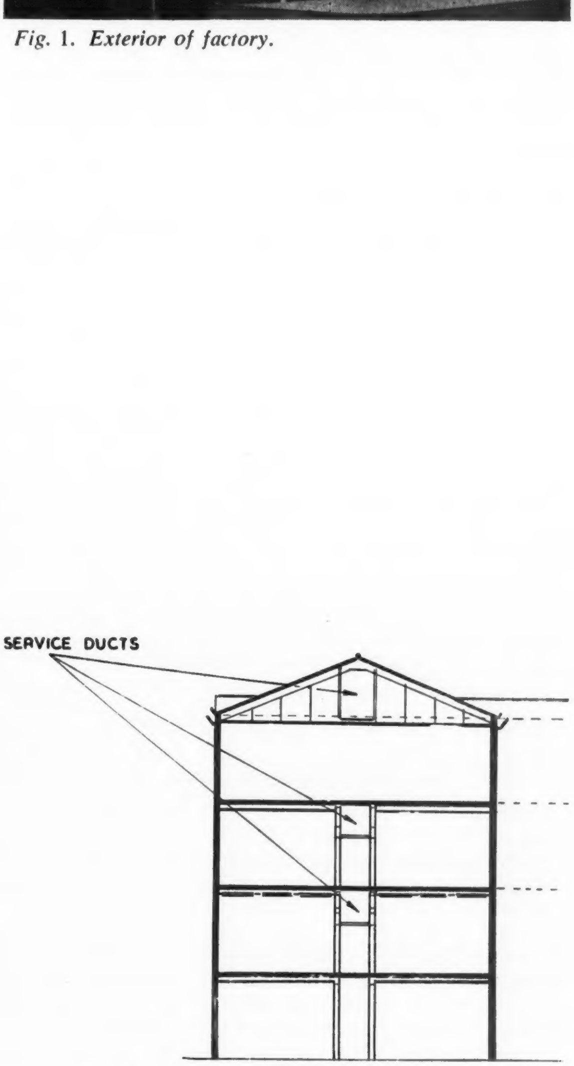


Fig. 2. Section of a wing of the factory.

in a single gear box in the service duct. Wiring for lampholder leads was taken from these panels by 1-in. conduit through each line of reflectors, each unit being provided with three individual leads with a common neutral for each row of three. Switching was arranged to operate reflectors in pairs, working parallel with the windows, so that inner rows of units could be switched independently to make up the centre illumination on dull days, or in advance of the outer rows as daylight faded.

Lamps are replaceable by removing the glazing of the reflector from below. The design of the aluminium extrusion carrying the reflectors makes this a comparatively simple operation. All auxiliary gear is immediately accessible from the service duct, and by a system of lettering and numbering of the bays it is simple to correlate the respective gear panels with their associated reflectors and lamps.

The solution of this lighting problem has covered several years of negotiation and design. Initially, considerable difficulty was experienced in the design and production of a satisfactory reflector suitable for vitreous enamelling and also conforming to the necessarily close tolerances.

Various shapes of flange were tried before the design was stabilised in the shape shown in Fig. 5.

The problem of manufacture was considerably intensified by the difficulty at this time of procuring high-grade sheet steel of vitreous enamelling quality, and the problem which gave rise to much thought and experiment was the provision of a simple and effective seal between the glazing, the ceiling extrusion and the reflector.

The solution finally adopted was to surround the glazing with a rubber gasket which is squeezed against the sides of the aluminium ceiling supports and the reflectors. It is simple to withdraw and replace the glazing for lamp replacement, yet the seal is effective and the installation is both dustproof and waterproof.

Fluorescent lighting equipment supplied by The British Thomson-Houston Company Ltd. was installed by The Humber Electrical Engineering Co., Ltd., Hull, under Smith and Nephew supervision. Smith and Nephew Ltd. have been responsible for the planning of the lighting, and they have also been instrumental in the co-ordination of the many parties concerned. The lighting fittings contract was placed through T. Beadle and Co. Ltd., of Hull, under the direction of Atkins and Partners, consulting engineers and architects. The Merchant Trading Company Ltd. were suppliers and erectors of the suspended ceilings.

Fig. 3. Interior of part of the factory.

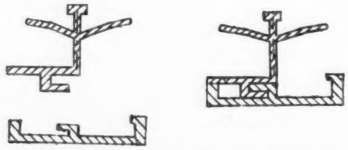


Fig. 4. Detail of aluminium extrusion.

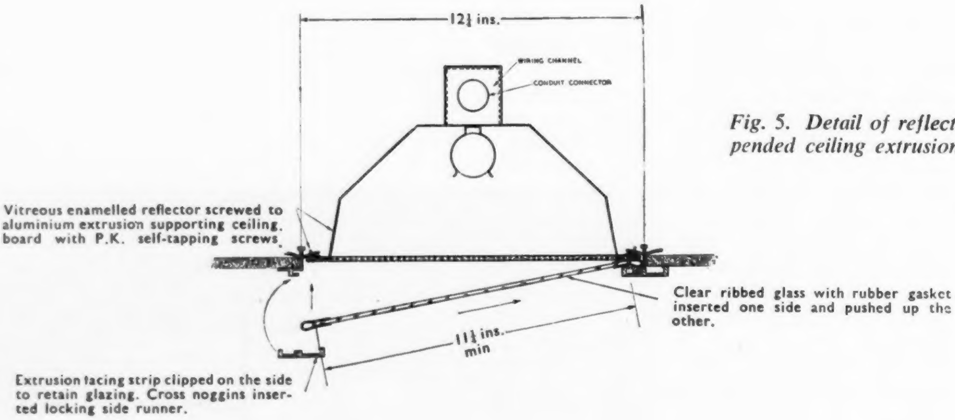


Fig. 5. Detail of reflector and suspended ceiling extrusion.

Electrical Engineers Exhibition

Lighting exhibits at the fourth Electrical Engineers Exhibition organised by the Association of Supervising Electrical Engineers and held at Earls Court, London, March 15-19, 1955.

The FALK, STADELMANN stand was designed to display the company's many industrial and commercial products. One of the most interesting exhibits was the "Imperial" high bay unit for use in industrial corrosive atmospheres. This unit houses a 300/500-watt tungsten or 400-watt m.v. lamp. In the same range the "Winston" caters for lower mounting heights, accommodating a 200-watt tungsten lamp, the distribution being dispersive. In the fluorescent range the main points of interest were the 1580 and 2580 vapour-proof fittings in which the gear is enclosed in a die-cast housing. Vitreous enamelled fittings and trunking were also shown. Pride of place was taken by the contemporary design fitting which was awarded a place of honour in a recent international competition as the best entry submitted by a British manufacturer. A number of other contemporary fittings were also displayed.

A representative range of lighting units for every branch of industry, commerce and public service was displayed by HOLOPHANE, LTD. The popular range of bulkhead fittings included a new circular recessed type for interior or exterior application. Another recent design of the bulkhead type was the "Side-of-House" lantern for use with 150/200-watt G.L.S. lamps or equivalent discharge lamps; primarily developed for Group "B" street lighting installations this lantern is also available with an alternative light distribution suitable for many lighting applications in industrial plants. Industrial reflector units for high and low bay installations were also on display. The high bay heavy duty fitting has been specially designed to provide efficient performance in conjunction with the 1,000-watt MB/U mercury discharge lamp. Two general purpose reflector units were shown of a new design with ventilated canopies for 300-watt and 500-watt G.L.S. lamps, providing intensive type light distribution with an upward component for low bay lighting. Flameproof lighting units for hazardous areas in oil refineries and chemical works, industrial translucent units and other fittings of a general and specialised nature were also exhibited.

Featured on the EDISWAN stand was the new shallow trunking for all types of lighting fittings and light duty power-operated equipment. The shallow form of this trunking makes it suitable for use in offices and stores as well as in factories, yet, because the whole of the interior of the trunking is available for cable, there is ample space for all wiring connected with the lighting circuits and for separate circuits supplying light duty power-operated equipment which may be mounted on the trunking or fed from socket outlets placed at any desired position on the trunking run. Other lighting equipment included standard fluorescent fittings, "Blendolite" industrial blended light units and street lighting lanterns. New items from the Ediswan Harcourt range were two decorative pendants, a recessed ceiling fitting for 100/150-watt lamps and a spun aluminium twin cone reflector wall bracket for two 60-watt lamps. Special hospital fittings were also on show. Two standard types of "Ensur-a-lite" emergency lighting equipment were shown, also a new small unit with the battery and charger combined, for use in small halls where space is limited and cost must be kept to a minimum.

The REVO display included a comprehensive range of public and industrial lighting equipment. The public lighting section included lighting fittings for Group "A" and "B" roads, using tungsten, mercury, sodium and fluorescent lamps, including the new "Haslemere" lantern (for 45-watt and 60-watt sodium lamps), a totally enclosed lantern with "Perspex" refractor bowl supported in a cradle bracket for post-top mounting. In the industrial lighting section many standard lines were displayed together with some recent additions including a blended unit carrying tungsten and mercury lamps and a new range of dispersive fittings available with over-lamp detachable reflector and cool wiring chamber designed for easy wiring and simple maintenance. Of special interest also was a new type of continuous sheet-steel trunking for fluorescent lighting designed to house the control gear and all necessary services, access to control gear, etc., being gained by means of removable side panels. It is arranged for direct ceiling mounting or conduit suspension and the reflectors can be attached to the trunking at any spacing as required. Other types of fittings included a mines roadway fitting in cast iron or die-cast aluminium, die-cast flameproof bulkhead fittings, floodlights and several airfield lighting units.

A huge sphere in which various unusual lighting effects are demonstrated, and a 14-ft. fluorescent wall of continuously changing colour controlled by electronic light-mixing equipment were among the main features of the THORN ELECTRICAL INDUSTRIES stand. A shop window setting demonstrated some of the many novel display lighting effects that are made possible by the new Atlas "Divider" Circuit equipment. This small and comparatively inexpensive unit, which is available for either automatic or hand operation, provides instantly the exact colour and quality of lighting appropriate to whatever goods are being displayed. Two new systems of built-in luminous ceilings were installed: one, the Atlas "Luminated" ceiling, employs continuous lengths of translucent corrugated white plastic sheeting. The other, Atlas "Louverex," is constructed in "egg-crate" fashion from white translucent plastic material. Other exhibits included a section of Atlas trunking, a new vapour-proof lighting unit, a redesigned version

of the "Lumos" spotlight and a new portable fluorescent lighting unit of the inspection lamp type.

The Benjamin Electric exhibited a complete range of tungsten mercury and fluorescent lighting fittings for indoor and outdoor use, the majority finished in "Crysteel" vitreous enamel. Introduced for the first time at this exhibition was a modified version of the well-known "Duoflex" floodlight for raising and lowering gear to facilitate cleaning and maintenance. Other new products were the "Duoflex" floodlight without inner reflector, adapted for use where a shorter throw is required; special pole clamps to enable the "Duoflex" to be attached to poles exceeding 4-in. diameter; and adjustable stops to enable the large specular and large vitreous floodlights to be freely swung in a vertical plane for cleaning and relamping and returned to original setting without further adjustment.

J. A. Crabtree and Co., Ltd., showed a wide range of electrical wiring accessories, including the popular "Lincoln" Type AC flush switches (in their single- and twin-unit form), together with their associated boxes of wood, steel and cast iron. The display was rounded off by a representative showing of switches and bell pushes, lampholders, ceiling roses, suspension switches, ceiling switches, and flush switch assemblies in both metal and shockproof type, together with sockets and switched socket-outlets in flush- and surface-mounting patterns.

Ashley Accessories, Ltd., exhibited "Ashley" guaranteed accessories for lighting and power installations featuring 13-amp. ring circuit accessories, including socket and switchsocket-outlets, fused plugs, fused adaptors, and selective entry spur junction boxes.

The Siemens Brothers Group of Companies exhibited a representative selection of products intended to give as wide a picture as possible of the range of electrical equipment manufactured by the Group. Cables, telephone equipment, switch and fusegear, lamps and lighting fittings, street lighting equipment, and photographic electronic-flash tubes were included. A feature of interest was the first public showing of the "Kuwait" fluorescent street lighting lantern. Designed and manufactured for the new city of Kuwait in the Persian Gulf, this lantern is now available on the home market. Lighting fittings were represented by a range of fluorescent and tungsten lamp units suitable for the home, office, shop and factory. Specially featured was the "Fleurlite" range of fittings for home use and providing a setting for indoor plants. The "Sierack" system of cable trunking and carrying was also featured.

The main theme of the Philips Electrical stand was the Philips trunking system, with an actual installation down each long side of the stand. New fittings for the Philips "Gear-less" fluorescent lighting system were on view. This system dispenses with starters and other control gear, using only a tungsten ballast lamp—itself a useful light source—to control the fluorescent lamp. Other exhibits included the new Philips 400-watt MBF/U mercury fluorescent lamp and sodium lamps and floodlights.

The Simplex Electric Co., Ltd., showed a new well glass lighting unit, which is available in two corrosion resistant finishes—L.216 cast aluminium, and L.217 vitreous enamelled cast iron. A variety of attachments make this unit adaptable to many methods of fixing and suitable to various installation positions both indoors and out. A new range of dust covers for spun reflectors, incorporating a unique method of attachment giving positive fixing and a very efficient dust seal were displayed for the first time. Other exhibits included bulkhead fittings, high bay reflectors, flameproof units and floodlights.

The British Thomson-Houston Co., Ltd., showed a wide variety of lamps and lighting equipment. Prominently featured was a shop window lighted by "Mazda" recessed louvered fluorescent fittings supplemented by "Cupola" adjustable reflector spotlight fittings. Universal lighting trunking and "Invertrunking" was installed on the stand to provide mountings for a display of industrial and commercial fluorescent lighting fittings, including two new fluorescent louvered diffuser fittings. Additions to the B.T.H. industrial range were a new horizontally operated 1-kw. mercury vapour lamp and an associated anodised aluminium reflector fitting.

Cayson Electrics Ltd. in addition to rectifying equipment for emergency lighting showed a range of tapped and untapped chokes and ballast units.

Courtney, Pope (Electrical) Ltd., on a stand which itself attracted a lot of attention showed their range of contemporary tungsten lamp units making a feature of the recessed and semi-recessed types. New items included the "Atomette" silhouette spot unit incorporating the Stelmar optical system. A wide range of fluorescent luminaires was also shown.

The main feature on the Crompton Parkinson stand was their "New Range" of industrial fluorescent luminaires by which 54 different fittings can be made up from 10 standard components.

Ecko-Ensign Electric Ltd. showed many of their industrial, commercial and decorative type fittings, including the fluorescent fitting made up from the design of the Building Research Station and which has recently been used in some quantity in a new drawing office.

Harris and Sheldon (Electrical) Ltd. showed a number of their tungsten lamp fittings in contemporary design as well as fluorescent industrial, commercial and decorative fittings. A feature of the stand was the demonstration of their "Handslite" louvering system by which 12 in.-square units of moulded translucent plastic can be built up to cover any required area of ceiling.

Linolite Ltd. showed their well-known reflectors and fittings and showed some new additions to the range.

A wide range of products was shown by the Major Equipment Co. Ltd., including neon and hot and cold cathode fluorescent lamps, and lighting fittings, floodlights and stage lighting equipment, including small dimmer boards, were also shown.

Stage lighting equipment was also displayed by Strand Electric. The Troughton and Young stand was devoted entirely to a new range of "Tubalux" fluorescent fittings designed to cover most requirements of industry and commerce. F. W. Thorpe Ltd. showed an extensive range of tungsten, fluorescent and discharge lamp fittings. New products included blended light and high bay units and floodlights for open spaces.

Architectural, neon and hot and cold cathode fluorescent lamps were shown by Longlamps Ltd. Luxram Electric showed a large variety of general purpose tungsten lamps and many lamps designed for particular uses.

Wm. McGeoch and Co. displayed lighting fittings for industrial use and for use on ships, railways, etc. Oldham and Son, Ltd., showed emergency lighting equipment and portable safety lamps for industrial and mining use. Dorman and Smith Ltd. displayed their flameproof and bulkhead fittings and portable safety hand-lamps. Vanguard Engineering Co. showed fluorescent fittings and control gear.

The lighting of the stand of James Kilpatrick and Son Ltd. took the form of a demonstration by Luminated Ceilings Ltd., with a colour change sequence controlled by G.E.C. equipment.

Correspondence

Shop Lighting, etc.

To the Editor, LIGHT AND LIGHTING.

Dear Sir,—Mr. Faulconbridge, who contributed to the correspondence columns of your March issue, knows so much more about shop lighting than I do that it is with some diffidence that I venture to disagree with his comments about the neglected state of small shop lighting—to which I referred in the Random Review.

Nevertheless, I doubt whether the question of fittings design is really one of the *main* reasons for poor small shop lighting. Mr. Faulconbridge is quite right in remarking about the relatively restricted range of fittings for shop lighting and their high costs, but this has been largely due to the deliberate policy of the Government to discourage anything other than the most utilitarian designs by the application of purchase tax. Nevertheless, I feel sure that there is in existence a considerable number of suitable designs which a competent lighting engineer could use to produce a satisfactory result.

As regards the colours of fluorescent tubes to which Mr. Faulconbridge refers, you will, of course, appreciate that the situation is much more complicated than appears on the surface, and whilst I would agree with him that there is a lot to be said for having colours whose spectral distribution is similar to that of a black body, I often think that much of the dissatisfaction which is all too frequently expressed in this matter is due to the fact that the characteristics of existing colours are not understood. Indeed, even within the lamp manufacturing industry, a surprising ignorance often betrays itself. Much of this confusion must, I think, be due to the way in which engineers describe the colour appearance of fluorescent tubes, and to the lack of a suitable nomenclature to indicate the characteristics of the colour rendition properties of the tubes.

The layman can understand that a lamp emitting 4,000 lumens gives more light than one emitting 3,000, even though he does not know what a lumen is, but he finds it odd when he is told that a colour having a temperature of 4,000 deg. K. is cooler than one having a temperature of 3,000 deg. K., and he just gives up when he is told that he can have two colours of the same temperature which have different effects upon the objects which they illuminate. As yet, there is no commonly accepted scale by which even technicians can describe simply the differences between the colour rendition of the various colours which are currently available. I suggest that until some simple system of describing the colours of tubes is adopted, we shall not make very much progress in providing the user with colours that he finds acceptable, because even if the colours are provided he would not know how to choose the one best suited for his purpose.

In this respect, I think our American friends have something to teach us by their adoption of the words "cool" and "warm" to describe the appearance of the tubes, and the words "standard" and "DeLuxe" to indicate the difference between tubes of poor colour rendition and those of good rendition. Although no Englishman is likely to regard the word "DeLuxe" with much enthusiasm, it is nevertheless well established and generally understood.

We have recently progressed some way towards acceptance of this concept by the introduction of it in regard to the warm white tubes, and it is my personal opinion that it would be advantageous if we followed this for the other colours, renaming "Daylight" "Standard cool white," with "Natural" as the corresponding "DeLuxe cool white."

Finally, Mr. Faulconbridge referred to my remarks about the change in technique of film studio lighting. I am afraid my remarks were too condensed to be very clear. The situation is, of course, that when sound films first appeared, the arcs were then so noisy as to be unusable, but by the time colour films became established developments in arc lighting had resulted in the noise level being reduced so that the high efficiency of the arcs could be utilised. As Mr. Faulconbridge says, this change back to arcs was largely made possible by improvements in the quality of the electric supply.

More recently, however, with the change in the spectral sensitivity of colour film which now suits the incandescent lamp better than the arc, studio lighting has once again reverted to incandescence, but it would be a brave man who would predict that arcs will not stage a come-back. Incidentally, I should be interested to know why Mr. Faulconbridge regards the continued survival of the arc lamp as "unfortunate." Technically, they are very interesting devices, and there is a lot to be said for having competition between different light sources in the studio world—as indeed there is elsewhere.—Yours, etc.,

London. A. G. PENNY.

Picture Lighting

To the Editor, LIGHT AND LIGHTING.

Dear Sir,—The problem of picture lighting in domestic interiors, raised by Mrs. Jacobs and effectively answered by Mr. Holmes, may have another solution.

Back in 1929 Mr. A. W. Beutell introduced the "K-Ray" device for lighting posters, announcement boards, menu boards, etc. In quite a number of domestic picture cases this method should have application. It involves, of course, some ingenuity in contriving the picture frame. Another advantage could be the protection afforded by the curved reflecting glass.—Yours, etc.,

Singapore. L. J. ROBERTSON.

Electric Lighting Fittings Association

The annual luncheon of the Electric Lighting Fittings Association was held on March 29 at the Piccadilly Hotel, London. During the course of his proposal of the toast of "Our Guests" Mr. C. J. W. Scott (who later in the day took over the office of president of E.L.F.A. from Mr. Cecil Hughes) referred to the many allied bodies, societies and associations concerned in one way or another with the lighting industry, and in particular mentioned the stimulus given by the I.E.S. The reply to the toast was made by Mr. E. C. Lennox, president of the I.E.S., who said that in spite of the good work done by the I.E.S. there were quite a number of people most intimately concerned with lighting who are not members of the society. The society, he said, aimed to bring about a better and wider use of lighting by co-operation between all concerned whether they be manufacturers of lamps or fittings, users or engineers. Lighting was now so cheap that all members of E.L.F.A., for example, should be concerned that the best use is made of the fittings they manufacture. Mr. Lennox said that examples of bad lighting were only too common; this was largely because the installations were designed (if designed at all) by those who are not qualified; because the provision of light is itself such a simple matter many people think there is nothing in designing an installation for which work their only qualification is some supposed natural instinct for the work. Lighting design, however, was far more than a matter of instinct. Mr. Lennox referred to the I.E.S. Register of Lighting Engineers which was intended to show which engineers have the necessary training and experience. This register, he said, may well in time grow to become a much-sought-after qualification.


D.2
F.31
C.26/300
C.15
C.19
D.8
P.6
D.7/P
M.6
C.164 Registered Design
D.28
D.15
D.123
D.71
D.107
D.98
D.130
NC.71
T.3
T.3/SM
C.26/200
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C.74
D.114
DX.10
NC.65, 66, 67
F.4
C.37
NC.63
D.7

I.E.S. Activities

PEEBLES MEETING

A week-end meeting arranged by the Edinburgh, Glasgow and Newcastle Centres will be held at the Peebles Hydro on May 6, 7 and 8. Papers will be given by J. M. Waldram and Jean Chappat. Full details of the meeting can be obtained from R. J. Fothergill, Northgate House, St. Mary's Place, Newcastle-upon-Tyne, 1.

The Brightness of the Stars

The third Trotter-Paterson Memorial Lecture was given on Wednesday, March 9, at the Royal Institution, by the Astronomer Royal, Sir Harold Spencer Jones, who spoke about the astronomer's work in the field of stellar photometry.

The Greek astronomer Hipparchus, in the second century B.C., divided the stars that could be seen with the naked eye into six classes according to their brightness. The brightest stars were called stars of the first magnitude; the faintest stars that were visible on a clear moonless night were called stars of the sixth magnitude; the stars of intermediate brightness were designated as second, third, fourth or fifth magnitude. These observations were recorded by Ptolemy in his great work, the Almagest, which gave the positions and magnitudes of something like 1,000 stars.

In succeeding centuries various astronomers carried on the work begun by Hipparchus, and during the eighteenth century the use of telescopes led to a rapid increase in the number of stars catalogued and to an extension of the magnitude system to much fainter stars. All the estimates of magnitude up to this time were purely visual, but except for the fainter stars they were reasonably concordant. It was recognised that the brightness ratio between consecutive magnitudes was approximately constant and photometric measurement showed that the value of the ratio was about 2.4 to 2.6, so Pogson in 1856 suggested that a convenient ratio to adopt would be 2.512, the fifth root of 100, as this would mean that a first magnitude star appeared exactly 100 times as bright as a sixth magnitude star and similarly for other magnitudes. This suggestion was adopted, and the only step then needed to establish the scale of magnitudes completely was agreement on an absolute value at some one point in the scale.

The lecturer then went on to describe the stellar photometers used for comparing the brightnesses of different stars. In some, like the Zöllner, a real star was compared with an artificial star produced by means of a lamp in the photometer, the intensity of the artificial star being varied by means of polarising prisms or a neutral wedge. In others, like the Meridian photometer, two real stars were compared by bringing their images close together in the telescope.

The most serious source of error in visual comparison arises from differences in the colours of the stars, and the magnitudes found by different observers are therefore not in agreement. It might be thought that a visual scale of magnitudes could be formed to represent the average human eye. This is not, however, practical and for precise photometry the eye has had to be abandoned in favour of other methods which are not subject to the same difficulties.

Atmospheric absorption, said the lecturer, was very troublesome, and it was this factor that set a limit to the accuracy attainable. Another source of error was possible change in the transmission of the optical train in the telescope. Both these errors were, however, much reduced owing to the fact that it was always a *comparison* between two or more stars, not an absolute measurement, that was being made. A certain group of stars of different magnitudes is used as a reference system, by international agreement, and all other stars are measured by comparison with some of these.

The application of photography to astronomy was soon followed by its employment for photometric observations. The early emulsions were all of the blue-sensitive type and it was soon realised that the system of magnitudes determined photographically differed from the visual system. The difference between the photographic and visual magnitudes of a star provides a measure of the colour of the star, called the *colour index*, which increases progressively with change of colour from the blue to the red stars. When a panchromatic emulsion is used in conjunction with a suitable colour filter, a colour rendering is obtained which approximates to that of the eye and a system of magnitudes can then be derived which simulates the visual system closely. This photovisual system, as it is called, has superseded the purely visual system.

Sir Harold Spencer Jones then went on to describe the various methods used in photographic stellar photometry, such as the use of a coarse wire grating over the telescope objective or the formation of out-of-focus images on the plate, with subsequent measurement of the density of the developed image. In the very ingenious Fabry method, a small auxiliary lens is used to form an image of the telescope objective on the plate, much in the same way as an image of an objective lens is formed on the retina of the eye in the Maxwellian view.

The photo-electric cell, because of its linear response, is ideal for setting up precise magnitude scales in different regions of the sky. It has also great advantages in variable star photometry, in which the brightness of a variable star is compared with that of two or three nearby stars of constant brightness. The high accuracy which is attainable with the photo-electric cell under favourable observing conditions is particularly valuable in this field of investigation. With the Crossley 36-in. reflector of the Lick Observatory the probable error of a single magnitude determination, using a photo-electric cell with electron multiplier, is $\pm\ 0^m.003$ at magnitude 13 and $0^m.03$ at magnitude 16.

The measurement of the apparent brightness of the stars is important because the determination of the distances of remote objects depends upon such measurements and an important question in cosmology is whether, at the greatest depths to which we can penetrate space—about 2,000 million light years with the 200-in. telescope—there is any evidence of a thinning out in the spatial density of the galaxies. One essential requirement for an answer to this question is the establishment of an accurate scale of magnitudes to beyond the twenty-third magnitude.

On this rather awe-inspiring note the lecture ended and the audience, after their thanks had been voiced by Mr. Guy Campbell and Mr. C. C. Smith, dispersed in thoughtful mood.

Sheffield Centre

The fourth Sessional Meeting of the Centre was held on February 14, when Mr. D. E. Jones presented a lecture entitled "Some Aspects of Industrial Lighting from a Factory Inspector's Viewpoint." There was a very large audience including many visitors. It is most encouraging to the Centre to see the continued increase in the attendance at meetings.

Mr. Jones mentioned that the first reference to lighting in Factory Acts was in 1896. He traced the history of the various regulations regarding lighting from that date. The first Act which specifically mentioned lighting was the 1937 one which states that sufficient and suitable lighting is

required, whether natural or artificial, and there shall be no glare, either direct or indirect. The type of illuminant is not specified. This statement applies to any part of a factory in which persons are working or passing.

Some legal requirements regarding lighting installations and other electrical plant were then discussed in detail. Here, Mr. Jones covered topics such as voltage reduction on portable electric lamps, flameproof fittings, efficient earthing, lighting in dusty and inflammable gaseous atmospheres, stroboscopic effect, accidents caused by plugs and switches, reflection factors and lamp mounting heights.

The advantages of improved lighting were stressed. Mr. Jones said that with increasing light came increased output, improved quality, a decrease in accidents, a tendency to better cleanliness, a general improvement in cheerfulness, apart perhaps from its beneficial effects on eyesight.

An interesting and lengthy discussion took place at the conclusion of the lecture in which 11 speakers took part. Several members commented on the very low values of illumination quoted by the Factory Acts. A vote of thanks to Mr. Jones was proposed by Mr. E. G. R. Taylor.

There was a good audience at the Sessional Meeting on March 14, when Miss H. M. Maurice, a member of the Centre and a director of the Wolf Safety Lamp Co. (Wm. Maurice), Ltd., presented a lecture entitled "A Brief Résumé of the History and Development of Mine Lamps."

Miss Maurice began by saying that the Romans mined tin and silver in this country and older civilisations extracted metal and precious stones from the earth. If they went far into the ground they needed a light of some sort. She then mentioned early open-flame lamps and the modern development of these, the acetylene lamp; the use of sunlight with an ingenious arrangement of mirrors to reflect light down to the shaft bottom had also been tried. It was pointed out that lighting from phosphorescent materials, such as partly putrescent fish skins, was tried in mines about 1790. Torches and candles had been used underground, and in the days before safety lamps and ventilation systems were also employed to light accumulations of fire damp and so clear them away.

The first attempt at a safety lamp was not a lamp at all, but what is known as a flint mill or wheel, which was invented by Spedding of Whitehaven between 1730 and 1750. At the beginning of the nineteenth century several attempts were made to produce a safety lamp for use in mines, and credit for first producing such a lamp usually goes to Sir Humphrey Davy, who discovered the safety principle of the wire gauze. The works of George Stephenson and Dr. Clanny were also mentioned in the lecture.

The next step was the production of flame safety lamps with a cylindrical glass round the flame, so that it could be clearly seen, with a short gauze mounted on the top of the glass. Early lamps had no locks, but experiments with magnetic locks were initiated as early as 1869, although none came into use until after 1884. By 1880 many safety lamps were available, and experiments had been made with different types of air feed and safety devices.

The revolutionary ideas of Carl Wolf were then dealt with, including the use of double gauzes for greater safety, a magnetic lock of unusual design and a special air feed. The first Wolf lamp embodying these features was available by 1884. The development and improvement in design of Wolf's lamp has resulted in the modern flame safety lamp for methane detection.

The first considerable installation of electric mine lamps used in England was installed at Murton Colliery, Co. Durham, in 1897, and employed 2-volt lead-acid accumulators. Information was given in the lecture on the use of alkaline batteries for this purpose. It was 1926 before portable electric mine lamps superseded flame lamps on a large scale, first in Germany and Holland and later in this country. During the next ten years many improvements were made to both acid and alkaline battery lamps to give simple design, improved safety, better light output, etc. It was not until 1934 that gas-filled miners' lamp bulbs became generally available, and about 1939 that the use of Krypton filling became possible on any scale.

Miss Maurice ended by discussing coal-mine lighting regulations and mentioned possible future developments. The lecture was illustrated by 49 exhibits.

There was an enjoyable discussion, and a hearty vote of thanks to Miss Maurice was proposed by Dr. F. A. Benson.

Leicester Centre

The Leicester Centre at their meeting on March 28 departed somewhat from their normal subjects, and were addressed by Mr. J. E. Hood and Mr. G. Whiteley on "The Use of X-rays in Medicine and Industry."

In their paper they discussed the principles of X-ray generation, and gave an historical survey from the early uses and applications to the present-day uses in hospitals and industry. It was pointed out that in the early days there was a considerable danger in using equipment of this nature owing to the high voltage and lack of protection for both patient and operator. Nowadays the design of equipment has been improved to a remarkable degree and, as well as being efficient, it is perfectly safe. Oil is now used as an insulating medium for the hot cathode X-ray tubes. Control panels have been streamlined and have good aesthetic appearance.

Birmingham Centre

The seventh sessional meeting of the Birmingham Centre was held on April 1 at the lecture theatre of the British Thomson-Houston Co., Ltd., Rugby, when members of Coventry Society of Architects were present. A lecture entitled "Lighting as an Effective Aid to Architects" was given by Messrs. Ruff, Mills and Bellchambers. Mr. Ruff, who opened the proceedings, dealt with light patterns and brightness; he was followed by Mr. Mills, who described the developments made in lamp design and the colour rendering of modern lamps. Mr. Bellchambers then took over and dealt with such items as light control, illumination design and light modelling, and also the effects interior decoration had on comfortable seeing conditions.

Mr. Howard Long opened the discussion, in which a large number of members and visitors took part, the meeting being brought to a close with a vote of thanks to the three speakers being proposed by Mr. Heydon and seconded by Mr. Draper.

I.E.S. Forthcoming Meetings

LONDON

May 10th

Annual General Meeting, Lecture on The Illuminated Chateaux of France, by J. J. Chappat. (At the Royal Society of Arts, John Adam Street, W.C.2), 6 p.m.

July 8th

Visit to the E.D.A. Testing House and C.E.A. Research Laboratories at Leatherhead. Depart from Victoria Embankment 1.30 p.m. (Cost 22s. 6d. Details from I.E.S. Secretary.)

CENTRES AND GROUPS

May 2nd

LIVERPOOL.—Annual Luncheon (Exchange Hotel, 1 p.m.). Annual General Meeting, followed by a survey of the Society's activities by the President. (At the Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool), 6.30 p.m.

May 5th

NOTTINGHAM.—Annual General Meeting. (At the Demonstration Theatre of the East Midlands Electricity Board, Smithy Row, Nottingham), 6 p.m.

Situations Wanted

CONSULTING post, or partnership, sought by Corporate Member I.E.S. (Registered), with considerable experience as senior lighting engineer in well-known firm. London or near. Box No. 887.

YOUNG DESIGNER and LIGHTING ENGINEER H.N.C. experienced in all aspects of lighting seeks post home or abroad offering sound prospects. Post other than with manufacturer considered. Box No. 890.

Situations Vacant

LIGHTING SALES ENGINEERS required London and Provinces, qualified and preferably with sales experience of commercial and industrial schemes. Write with full particulars of experience and salary required to Ref. MD/P2/SSV1, Crompton House, Aldwych, London, W.C.2.

The British Thomson-Houston Co., Ltd., require a PHYSICIST or an ELECTRICAL ENGINEER in their research laboratory at Rugby for work connected with the development of new types of electric lamp. In addition to the determination of the physical design and measurement of electrical and optical characteristics, the work involves the development of the associated circuitry which is often of special nature. Applicants are invited to send particulars of their qualifications to the Director of Research, British Thomson-Houston Co., Ltd., Rugby, quoting Reference BE.

ASSISTANT TO STREET LIGHTING ENGINEER required to help in the development and application of a wide range of Street Lighting equipment. A knowledge of Street Lighting technique is desirable. Excellent opportunity for a young man with initiative. Write, giving details of qualifications and salary required, to Thorn Electrical Industries, Ltd., 233, Shaftesbury Avenue, London, W.C.2.

Fully trained LIGHTING ENGINEER required for London office. Applicant must be well educated and conversant with modern lighting methods. Apply Senior Lighting Engineer, Ekco-Ensign Electric, Ltd., 45, Essex Street, Strand, W.C.2.

JUNIOR RESEARCH ENGINEER. The Lamp and Lighting Division of the Research Laboratory has a vacancy for a young man with a degree, H.N.C. or equivalent qualifications in electrical engineering or physics for investigations into the performance of discharge lamp circuits and field operational problems. Please write, giving full particulars, to the Director of Research, the British Thomson-Houston Co., Ltd., Rugby, quoting reference MVR.

LIGHTING ENGINEER required for West End Lighting Fittings Manufacturers to prepare lighting layouts for all types of interior installations. Apply, stating full particulars of experience and salary required to Box No. 888.

LIGHTING FITTINGS DESIGNER required for West End firm of Fittings Manufacturers. Previous experience in similar position essential. Apply, stating full particulars of experience and salary required to Box No. 889.

SENIOR LIGHTING SALES ENGINEER required for Midlands Area. Applicants must be experienced commercial men with sound knowledge of the industrial market. Excellent prospects for keen capable man. Apply with full details of age, experience and salary required—British Thomson-Houston Co., Ltd., John Bright-street, Birmingham.

TECHNICAL ASSISTANT (21-35) required for the Illuminating Engineering Service Department for the planning of lighting installations. Apply, stating age, experience, salary required, to Chief Lighting Engineer, The Benjamin Electric Ltd., Tottenham, London, N.17.

Physical Society Colour Group

Members of the Colour Group of the Physical Society met on February 23 to listen to an account, given by Mr. T. H. Vinnicombe, of the new "Colorizer" system by which paints can be made up in a matter of seconds to match any one of a wide range of colours. There are 16 basic colorants put up in tubes of several standard sizes and one of these, when mixed with a base, again of a given volume, produces one standard tint, there being six tones in each colour. Either one or two colorants may be used to produce a given shade, the proportions necessary being shown on a shade card, next to a sample of the colour which results from the mixture.

The lecturer described the way in which the colorants are adjusted to a precise standard, so that any mixture of the prescribed proportions always results in exactly the same shade, and he demonstrated this reproducibility with actual materials.

The lecture was preceded by a film describing the Ostwald system of colour specification and the way in which the use of readily reproducible shades simplifies the task of the home decorator.

At the annual general meeting of the group, held on March 30, Mr. R. G. Horner was elected chairman and Dr. R. A. Weale the honorary secretary. The retiring chairman, Dr. L. C. Thomson, gave an interesting address which, although announced as being on "The Part Played by Electrophysiology in the Investigation of Visual Mechanisms," was actually confined to an account of work with the microelectrode technique developed and used by R. Granit.

Dr. Thomson feelingly described the difficulties which beset the experimenter in this field who attempted to measure the responses in single cells of the retina or in single fibres of the optic nerve, using an electrode consisting of a wire about one-hundredth of a millimetre in diameter. He mentioned the various types of electrodes which had been devised and said that there were three main questions which the experimenter had to ask himself and to answer, viz., what electrode to use, where to put it and what animal to choose for his experiments. He showed how the technique had been used to find out the size of the retinal field connected to a single receptor and therefore forming a single unit as far as the visual sense was concerned. He showed a number of records of the impulses of potential in the optic nerve following the onset or cessation of retinal illumination, and he discussed some of the results of attempts to explore the spectral sensitivity curves of different receptors in the retina of the eye.

Errata

In spite of what we thought was careful attention to detail one or two errors crept into the International Random Review which we published in April.

The photograph of the Langebro Bridge, Copenhagen, which appeared on page 125 should have been credited to the Philips company and we would apologise to both the company and to Mr. Knudsen (who supplied us with the correct information) for any inconvenience caused to them.

The other error was in the spelling of M. Gaymard's name on page 127—such an old friend deserves to have his name spelt correctly and we apologise to him also.

POSTSCRIPT By "Lumeritas"

The annual meetings of the British Association for the Advancement of Science are always interesting, a wide variety of topics being discussed by an equally wide variety of scientists, together with laymen who have scientific interests. The meeting this year is to be held in Bristol from August 31 to September 7, and although the programme has not yet been published, I understand that there is to be a session on Lighting and Vision among those arranged by the Physiology Section of the Association. This session will include four papers and I believe that three of these are to be given by Past Presidents of the I.E.S., namely, Mr. H. C. Weston, Mr. J. G. Holmes and Mr. W. R. Stevens. The fourth paper is to be given by Dr. W. F. Floyd, a physiologist who was a prominent member of the Post Office working party to which I referred last month. It is not often that lighting gets such a good "look in" at a British Association meeting, although I believe that at a fairly recent meeting a paper was presented by Dr. J. N. Aldington. I recall, too, that in 1948 the Association held a Conference on Human Factors in Industry, under the auspices of the Division for Social and International Relations of Science, at which Mr. Weston read a paper on lighting. This year, then, the subject of lighting is likely to be "in the limelight" both at home and abroad, for the Bristol meeting of the British Association will be preceded by the meeting of the International Commission on Illumination at Zurich in June.

I understand that publication of a revised version of the I.E.S. Code is imminent. It was 23 years ago that the Council of the I.E.S. first decided to prepare a British Code of Lighting and instructed its Technical Committee to undertake this work. As then contemplated, the code was to be concerned mainly with values of illumination, and it was at this time that Mr. A. W. Beuttell proposed an analytical basis for the code, involving a method of computing values of illumination for various classes of work. At the end of 1933 Beuttell read a paper describing this method to the I.E.S. In the following year Mr. H. C. Weston—under the aegis of the Industrial Health Research Board and the Illumination Research Committee of the D.S.I.R.—commenced a series of experiments, in co-operation with the Light Division at the N.P.L., to determine some of the basic relationships which Beuttell recognised must be known before his method could be developed. This basic work was still in progress when, in 1936, the Society published the forerunner of the code under the title "Recommended Values of Illumination." A first revision of this publication followed in 1937, a second revision in 1941 and a third revision in 1942. The latter was the first to be titled "I.E.S. Code" although each of the preceding versions opened with the words "This code gives. . . ." In 1943, Weston read a paper before the I.E.S. dealing with "Proposals for a New Lighting Code" based partly on the results of the series of experiments already mentioned. When the war terminated in 1945 a new I.E.S. Code was issued embodying some of these proposals. This code was revised and improved in 1949 and became very widely known and used. It is now out of print and no doubt the drafters of the 1955 version will have taken into account recent advances in our knowledge of what constitutes good lighting.

I see from the *Farmers' Weekly* that fluorescent lighting is now being used for chitting (or sprouting) early seed potatoes. This is done by hanging fluorescent tubes vertically in a chitting house between stacks of trays containing the seed potatoes. I wonder if this effect of fluorescent light upon the "eyes" of potatoes is regarded as harmful by Mr. G. V. Downer—that "forthright independent authority on lighting" (*vide The Recorder* recently)? Mr. Downer loses no opportunity of publicising his assertion that there is no reasonable doubt that fluorescent lighting is harmful to eyesight, although he never supports his assertion by any evidence which his readers can verify. In his latest article in *The Recorder* on domestic artificial lighting, he supplements his arguments for tungsten indirect lighting as the best for all parts of the home by his usual denunciation of fluorescent lighting. The harmful effect of fluorescent lighting, he says, "has been experienced by innumerable doctors and eye specialists." How has he obtained this astonishing piece of information? Certainly not from the medical literature, where one would expect to find case reports of the harmful effect by at least an impressive number of the "innumerable" afflicted medicos! On the other hand, if he were to pay a visit—as I have done—to the Institute of Ophthalmology in London (and it is almost within a stone's throw of Mr. Downer's operational headquarters) he would find this centre for research into the physiology of vision and the diseases of the eye, as well as for the teaching of ophthalmology, entirely equipped with fluorescent lighting—as it has been for the past five years! In the clinical department he would find the familiar wall charts used in sight-testing illuminated by fluorescent tubes. And if he obtained an audience of the Director of Research—an ophthalmologist of world-wide renown and occulist to H.M. the Queen—or of the Dean, another eminent eye specialist, he would find them both in rooms equipped with fluorescent lighting! If he then visited the lecture theatre (hither, from the five continents, come aspirants for the Diploma in Ophthalmology, to be taught by our leading ophthalmologists) he would find fluorescent lighting here too. The present installation here—which was described last January in *Light and Lighting*—was not designed by what Mr. Downer might regard as a misguided lighting engineer or a "so-called lighting expert," but by Dr. L. C. Thompson—a vision expert! Now, how does this square with Mr. Downer's assertion that eye specialists have found fluorescent lighting harmful? Were it harmful I can imagine no more unlikely place to find it than this Institute. The "forthright independent lighting authority" would be well advised to confine his future pronouncements within his own limited field of knowledge.